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**SIXTIETH ANNUAL REPORT
OF THE
NORTH CAROLINA
AGRICULTURAL EXPERIMENT
STATION**

R. Y. WINTERS, Director

**THE NORTH CAROLINA STATE COLLEGE OF
AGRICULTURE AND ENGINEERING OF THE
UNIVERSITY OF NORTH CAROLINA**

AND

**STATE DEPARTMENT OF AGRICULTURE
COOPERATING**

**STATE COLLEGE STATION
RALEIGH**



**FOR THE FISCAL YEAR ENDING JUNE 30, 1937
PROGRESS REPORT FOR YEAR ENDING
DECEMBER 1, 1937**

North Carolina State Library



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STATE INSTITUTIONS COOPERATING IN AGRICULTURAL RESEARCH



STATE COLLEGE OF AGRICULTURE AND ENGINEERING OF THE UNIVERSITY OF NORTH CAROLINA State College Station, Raleigh, N. C.

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C. H. BOSTIAN	Poultry Genetics

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B. B. FULTON	Associate Entomologist

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BRYAN HARRIS	Herdsmen

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K. J. SHAW, Raleigh, N. C.	Assistant Tobacco Investigations, U. S. Department of Agriculture
T. E. SMITH	Assistant Tobacco Investigations U. S. Department of Agriculture

Upper Coastal Plain Test Farm—Rocky Mount

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WM. ALLSBROOK	Herdsman
J. P. YOUNG	Assistant Tobacco Investigations, U. S. Department of Agriculture

SIXTIETH ANNUAL REPORT
of the
NORTH CAROLINA AGRICULTURAL EXPERIMENT STATION
For the Year Ending
June 30, 1937

It is natural to accept our public service institutions as a matter of course, without much consideration of their background, their origin, and development of functions, so important to the public welfare.

The current year marks the seventy-fifth anniversary of the establishment of the United States Department of Agriculture and the Land Grant Colleges. It marks the sixtieth anniversary of the North Carolina Agricultural Experiment Station. The Acts of Congress which provided for the United States Department of Agriculture and the Land Grant Colleges were not sporadic attempts to serve or appease those engaged in agriculture. Their origin is found in the thoughtful and intelligent planning over a period of years by the true leaders of thought in the Nation. The origin of the North Carolina Agricultural Experiment Station by the General Assembly of 1877 has an equally interesting background which has never been fully recorded. Some work was done in collecting historical material for the celebration of the fiftieth anniversary, and contributions were made by present and former staff members, but the record is by no means complete. The leadership of Kemp P. Battle, President of the University at Chapel Hill, is partly recorded and recognized. The valuable contributions of W. C. Kerr, State Geologist, have not been recorded or generally recognized. As time passes one must deal with the increasing difficulty of securing accurate records.

The following news items related to the origin of the North Carolina Agricultural Experiment Station are appropriate to this account of its activities during the sixtieth anniversary:

"Kemp P. Battle, president of the University, arrived in the city Tuesday evening. He had been on an extensive northern tour. He went first to see the institute of technology at Boston, then to the Bussey experimental farm three miles from Boston, then to the Sheffield Scientific Academy, a part of Yale College at New Haven, then the Connecticut experimental farm at Middletown, under the charge of Professor Atwater, of the Wesleyan University, the Connecticut State Fair at Hartford, then to the Massachusetts Agricultural College at Amherst, then the Williams College at Williamsboro, Massachusetts, where is a valuable collection of fossils and minerals made by Professor Emmons during his office of State Geologist in North Carolina, then to the School of Mines at Columbia College, New York City, and then to the agricultural college at New Brunswick, New Jersey, under the charge of Professor Cook, of Rutgers College. He then examined the educational expositions at the Centennial and went to Washington where he received promises of mineralogical and other specimens for the museum now established at Chapel Hill. He informed himself of the results of the experiences of these institutions in carrying out agricultural and other experiments, and the modes found to be best by such experience for agricultural and scientific

education. In due time he will communicate to the trustees and to the public the conclusions he has arrived at. (Raleigh Sentinel, Oct. 5, 1876)."

"Report of Conference Committees of the Grange and the University"

"Pursuant to previous notice, and by virtue of appointment of the proper authorities, the conference of committees appointed by the several agricultural societies of the state—the State Grange of Patrons of Husbandry with the State Geologist and a committee of the Faculty of the University, was held at rooms of the Geological Survey at 10 a.m., yesterday.

On motion of Col. J. M. Heck, Dr. Columbus Mills was elected chairman, and on motion of President Kemp P. Battle, Capt. C. B. Denson was elected secretary.

President Battle, at the request of the Chair, explained that the object of the meeting was to concert measures for the improvement of the agricultural interests of the state, and more especially to take the initial steps in securing a practical experimental agricultural station for the analysis of fertilizers and soils, and of eventually adding thereto experiments in culture and farm management. He gave facts and figures in full to show the great value of such a station to the farming community, illustrating his remarks by ready reference to the experience of Connecticut and other states.

Prof. Redd, of the University, followed with remarks in reference to the practical details of the work of such a station, and exhibited the advantages offered by the University for its establishment at that point, with the aid of sufficient means for the payment of a permanent chemist devoted solely to such work.

Prof. Kerr, the State Geologist, forcibly exhibited the defects of the present law in regard to the analysis of fertilizers, and related fully and satisfactorily the results of the operation of the various state laws. Among other facts of importance to the farming interest, he showed that cargoes of fraudulent fertilizers had been denied admittance to other states, and then sent to North Carolina to be sold, to the damage of our farmers.

Upon motion of Col. Heck, to lay the subject before the legislature, and request the establishment of an experimental station, interesting discussion followed as to the means to accomplish the good desired by the farming community; in which Prof. Kerr, President Battle, Col. L. L. Polk, Capt. Denson, Gen. R. F. Hoke, and Prof. Smith of the University, participated.

The resolution was adopted, and the chairman appointed the following committee to mature the details of the proposition, to be submitted to a meeting of the conference today: Messrs, Kemp P. Battle, W. C. Kerr, L. L. Polk and R. F. Hoke, to which the chairman was added.

On motion, the conference adjourned to 10 a.m., Wednesday, to receive the report of the committee."

COLUMBUS MILLS, Chairman,
C. B. DENSON, Secretary."

(The Observer, January 3, 1877)

THE RESEARCH PROGRAM

The research program of this Station is devoted to the impartial study of problems which concern the welfare of those engaged in agriculture. The studies concern problems peculiar to the farming region and those which relate to mutual services between agricultural and other groups.

The segments of research which collectively compose the program deal with practical problems of economy in production, improvement in quality, effective distribution, new farm enterprises, cooperation, and other human relationships important to the farm community and the state as a whole.

Research projects well considered and planned represent an obligation to those they are proposed to serve. This obligation requires that projected work shall be completed and its findings made available to those for whom they were intended. The completion of even simple research undertakings require time if the results are to be trustworthy. Variable seasons and variations in the response of soils, plants and animals require caution and time for the verification of results.

There exists at times a feeling of impatience among growers and others toward the slow process of fact finding and the lack of proven information. The danger lies not so much in the existence of impatience but in its stimulation of superficial tests and practices which are misleading. Expressions of impatience are useful in directing the attention of research workers toward needed information. Expressions of impatience would be doubly useful if they were also directed toward support for research personnel and facilities.

The processes of research do more than develop useful information. Under conditions of continuity and concentration it develops needed leadership which combine information, personality and force for good. The frequent change in research personnel defeats this important purpose.

Leaders in specialized fields of research have not fully realized their opportunities for converting their findings into action. Published reports are usually inadequate for this purpose. Too often the schedule of research or research and teaching will not permit more than published results. In certain fields of study this Station has accumulated valuable information, much of which has been published. In those fields where the programs of agricultural extension and vocational agriculture parallel in purpose the problem is relatively simple. Some of the information relates to problems outside of the direct functions of these agencies. Accumulated information on farm real estate tax rates, delinquent taxes, county budgeting in relation to farm taxation may require broader cooperative contacts to induce logical action. Accumulated information on cotton marketing in relation to cotton improvement and standardization will require the attention of those engaged in various phases of cotton marketing as well as those concerned with marketing education if proper adjustments are to be made.

Published results of this Station are not fully effective, due to the limited editions. Three to five thousand copies of certain issues are inadequate for the needs. Certain issues are out of print within sixty days of the time of their publication, and a large portion of the distribution is in response to written requests. The insistent requests of vocational schools have never been met in adequate numbers. State policy has provided free texts for school use but has failed to provide adequately for publications relating to local agricultural conditions so much needed to supplement the general texts and instruction.

NEW WORK AND PERSONNEL

The completion of old work and support for new work has given opportunity for starting work which has been under consideration for several years and planning new work appropriate to recent problems. Consideration has been given to the soil fertility and conservation problems and the organization of research for meeting them. Plans were completed for the establishment of better laboratory facilities and for the addition of laboratory personnel. The plans also concerned a greater concentration of personnel with reference to areas of the state and subject matter, though the plans provide for collective team work among specialists.

On January 1, 1937, R. W. Cummings was appointed associate in soils research to study soil chemical and physical relationships to the prevalence of Granville wilt of tobacco. The work is organized in cooperation between the departments of Agronomy and Plant Pathology. The project has also been made a part of the joint program on tobacco investigations between the Station and the Federal Bureau of Plant Industry.

During the year cooperative planning and work was established between the Station and the Soil Conservation Service for the study of economic and social changes resulting from a planned program of soil conservation in Franklin county. The study proposed to record farm management changes for soil conservation under the program and relate these to changes in the economic and social status of the farm groups occupying the area. The plans provide for progressive change based upon experience, outlook and the analysis of annual records.

Attention has also been given to the planning of work requested by the Brushy Mountain Fruit Growers for the study of problems peculiar to the apple growers of this and adjoining areas of apple production. The General Assembly of 1937 provided an annual appropriation of \$5000 for this purpose during the 1937-39 biennium.

Research planning has also given consideration to problems of the peanut growers and has made adjustments which provide more time for work on peanut diseases, unfavorable soil conditions and improvement by breeding. One project for the study of disease control was started on the farm of James Shields near Scotland Neck, N. C., during the year.

From time to time requests have come from the North Carolina Crop Improvement Association for increased work in crop variety testing. In the face of limited funds for research the Experiment Station has held that the time might better be spent in the study of crop qualities and the development of superior strains than in the testing of a large number of varieties, most of which are not receiving intelligent selection and breeding. The Station has established certain standards within all the major field crops and has concentrated upon the further study and improvement of these. Plans have been completed for the strengthening of this work during the new year.

The problem of variety testing can serve a useful purpose for many of the varieties now grown are inferior in yield and quality. In a few cases county agents and vocational teachers have conducted elimination tests in their various communities. This should be more generally done to

establish regional standards. This could also be done through the distribution of seed known to have superior quality.

The problem of internal parasites in poultry of North Carolina has been recognized by poultrymen of the state, and its importance has been very evident to the research staff of the Poultry Department through their post mortem examination of large numbers of birds sent in by producers. A small start has been made on this problem through the appointment of Dr. R. Harkema to part time research in this field. Special attention will be given to the identification of tapeworms infesting fowl in North Carolina and their relation to leg weakness and blindness.

PUBLICATIONS

The following publications were issued by the Experiment Station or arose through cooperative work with the United States Department of Agriculture:

- Soil Survey Report of Lee County, North Carolina*, by S. O. Perkins and E. F. Goldston (published by U. S. Department of Agriculture).
- Soil Survey Report of Franklin County, North Carolina*, by W. A. Davis, E. F. Goldston and C. H. Wosner (published by U. S. Department of Agriculture).
- Soil Survey Report of Brunswick County, North Carolina*, by S. O. Perkins and E. F. Goldston (published by U. S. Department of Agriculture).
- Gin Damage of Cotton in Relation to Rainfall*, by Glenn R. Smith, Bulletin No. 306 (August, 1936).
- Production and Quality of Meat from Native Grade Yearling Cattle*, by Earl H. Hostetler and John E. Foster, Coop. U. S. D. A., Bulletin No. 307 (November, 1936).
- Influence of "Rust" on Quality and Yield of Cotton and the Relation of Potash Application to Control*, by J. H. Moore and W. H. Rankin, Bulletin No. 308 (May, 1937).
- Recent Changes in the Social and Economic Status of Farm Families in North Carolina*, by C. Horace Hamilton, Bulletin No. 309 (May, 1937).
- Beef Cattle Production in the Blackland Area of North Carolina*, by J. E. Foster, Earl H. Hostetler and L. I. Case, Bulletin No. 310 (May, 1937).

TECHNICAL BULLETINS

- A Study of Naturally Infected Cases of Fowl Typhoid*, by H. C. Gauger, Technical Bulletin No. 53 (April, 1937).

TECHNICAL ARTICLES

- Results of the Mechanical Application of Acid and Neutral Fertilizers to Cotton in North Carolina*, by Emerson R. Collins, Agronomist, N. C. Agricultural Experiment Station, and J. J. Skinner, Bureau of Plant Industry, U. S. D. A. Proc. of the 12th Annual Meeting of the National Joint Committee on Fertilizer Application, 1936.
- Adapting High Analysis and Concentrated Fertilizers to Cotton Soils*, by J. J. Skinner, H. B. Mann and E. R. Collins, U. S. D. A. and N. C. Experiment Station, E. E. Batten, Va. Experiment Station, R. P. Bledsoe, Ga. Experiment Station, Soil Science 44 (1937).
- The Relation of Free Iron in the Soil to Aggregation*, by J. F. Lutz, Soil Science of Amer. Proc. Vol. 1, 1937.
- A Study of Farm Organization and Soil Management Practices in Franklin and Wilson Counties*. Prepared by Research Committee of the N. C. Ex-

- periment Station, Feb. 22, 1937, by G. W. Forster, R. Y. Winters, C. B. Williams, J. F. Lutz and Olaf Wakefield.
- A *Study of Farm Organization and Soil Management Practices in Franklin and Wilson Counties, North Carolina*. A summary of the Franklin County Data, by J. F. Lutz, 1937.
- A *Revision of the Genus Megachile in the Nearctic Region*, by T. B. Mitchell, Part V, Transactions of the American Entomological Society, Vol. 62, pp. 323-382.
Part VI—Vol. 62, pp. 45-83.
Part VII—Vol. 63, pp. 175-206.
Part VIII.
- Trends of Fecundity of Married Women in Different Social Groups in Certain Rural Areas of North Carolina*, by C. H. Hamilton, Rural Sociology, Vol. 2, No. 2, June, 1937.
- Experimental Crossing of Subspecies in Nemobius (Orthoptera: Gryllidae)*, by B. B. Fulton, Annals Entomological Society of America, Vol. 30, pp. 201-207, June, 1937.
- Evidences of the Significance of Oxidation-Reduction Equilibrium in Soil Fertility Problems*, by L. G. Willis, Soil Science of America Proceedings, Vol. 1, 1937.
- The Stimulation of Seedling Plants by Organic Matter*, by J. R. Piland and L. G. Willis, Journal of the American Society of Agronomy, Vol. 29, No. 4, April, 1937.
- Some Recent Observations on the Use of Minor Elements in North Carolina Agriculture*, by L. G. Willis and J. R. Piland, Soil Science, Vol. 44, No. 4, October, 1937.

AGRONOMY INFORMATION CIRCULARS

- No. 101. *Tobacco Fertilizer Recommendations for 1937*. (July, 1936.)
- No. 100. *Results of Crop Rotations in Coastal Plain, Piedmont and Mountains*, by C. B. Williams, (July, 1936).
- No. 102. *I. Factors in Soybean Production. II. Variety Recommendations and Characteristics*, by R. L. Lovvorn and P. H. Kime. (Jan., 1937).
- No. 103. *Suitable Fertilizer Mixtures for Different Crops, Including the Functions of the Chief Plant Nutrients*, by W. H. Rankin. (Feb., 1937).
- No. 104. *Investigations on the Mechanical Application of Fertilizers for Cotton in North Carolina, with Some Results for Other Crops Obtained in Other States*, by Emerson R. Collins. (Feb., 1937).
- No. 105. *Results of Cotton Variety Experiments, 1931-1936*, by P. H. Kime. (March, 1937).
- No. 106. *Fertilizers for Different Crops, Including the Best Percentages of Water-Insoluble Nitrogen of Totals in Fertilizer Mixtures*. (April, 1937).

SOILS APPRAISED FOR FARMERS

During the year about four thousand sample of soils have been examined and appraised for farmers of the state and specific fertilizer, lime and crop recommendations made based upon the examinations and a knowledge of the fertilizer, lime and crop requirements of North Carolina soil types. The farmers of the state are greatly appreciating the value of this service, as is evidenced by the increased number of soil samples they are sending in for examination from year to year. This service gives the Department of Agronomy workers an opportunity to contact farmers and to become more intimately acquainted with their problems, as well as

helping them in the economic solution of their soil, lime, fertilizer and crop needs.

The examinations consisted in the main of establishing the soil types, their physical condition, their approximate content of organic matter, and their pH readings. The information resulting from the examinations coupled with the results from field experiments enabled the appraiser of the Department to give reasonably accurate recommendations with reference to what should be done in each case in the way of the best fertilizer, lime and other treatment to the soils for the producers to get best paying results for the crops grown on their farms.

The examinations have shown that many soils of the state are suffering from acute plant food deficiencies which have to be corrected before normal and profitable crop growth and yields can be obtained.

PROGRESS OF CURRENT RESEARCH

I. SOIL RESEARCH

County soil surveys of the State.—The soil survey work, conducted co-operatively with the Tennessee Valley Authority and Federal Bureau of Chemistry and Soils, has gone forward actively during the year. All the survey work, except that which has been carried on in Warren county, has been done on a scale of 2.6 inches to the mile, which means the work is done in far greater detail and is therefore much slower than was the case in previous work when a scale of one inch to the mile was used. During the year 53.4 per cent of Warren, 60.8 per cent of Swain, 45.1 per cent of Transylvania, and 6.7 per cent of Jackson counties have been finished.

By means of this work the soils are identified and classified in the T.V.A. area of the state into separate types based upon their physical and chemical characteristics, such as natural features or stoniness, slope, geographical position and drainage, together with the extent of erosion, degree of plant food exhaustion, present productive capacity, potentialities, and other characteristics. The reports prepared by the field men in the field before they leave the areas for the different counties are edited and published by the United States Department of Agriculture. These reports with the accompanying maps are being found of very great service to agricultural workers and farmers. The demand for them is so great that it is almost impossible to keep a supply on hand for distribution. (C. B. Williams W. A. Davis, E. F. Goldston, William Gettys and C. W. Croom, Cooperation Bureau of Chemistry and Soils and T.V.A.)

Chemical Research on some technical soil problems.—Much of the experimental work of the past several years has reached a point where it has been possible to publish some of the details. During the year Willis and Piland have submitted three articles to technical journals and several others they state can be prepared for publication as soon as the pressure of other work permits covering their findings on research projects.

Since recent experiences, having turned attention to the use of hypoductive methods of research, it has become obvious to them, they state, that many of the conclusions derived from past research are in some degree incorrect. They think, too, there is a very evident need for a more careful analysis of the logic of research, particularly as it pertains to soil fertility problems.

All of the active projects in soil chemistry have been found to be mutually overlapping to such a degree that it has been impossible to carry out the work of any of them independently. It has also been demonstrated that a similar relationship exists between these and numerous other details of the soil fertility problem. They state that the perspective is so broad that considerable attention has been given by them to collateral items. (L. G. Willis and J. R. Piland.)

Reductivity intensity in soils as evidenced by soil potential drifts (No. 197).—Reconnaissance studies of this problem have supported a con-

clusion that significant but transitory oxidation-reduction intensities may develop in soils and influence plant growth although the corresponding potentials may not be measurable by laboratory methods. This has made it necessary to proceed toward approximate proof by a process of testing theories. It has not been considered advisable to state some of the theories formally inasmuch as they constitute the origin rather than the objective of the current research.

In much of the work of this project it has been necessary to consider the function of some of the minor elements. Evidence that copper and manganese may act as catalysts of oxidation has been substantiated. The effect of these two elements has therefore been used as a means of diagnosing obscure soil conditions. In several formal and informal experiments it has been shown that either copper or manganese will control plant abnormalities that have been considered specifically symptomatic of a deficiency of potassium.

This suggests to the workers on this project a non-nutrient function of potassium which is associated in some manner with the oxidation reduction problem. Conversely, it has been shown that phosphates aggravate an adverse soil condition, that either copper or potassium will correct. One experiment supplies evidence that a lethal effect of phosphate on soybeans is indicative of a phosphate deficiency in the soil.

Oxidation-reduction involves, therefore, nearly all the major phases of the soil fertility problem and the project is capable of almost indefinite expansion. (L. G. Willis and J. R. Piland.)

Boron deficiency in North Carolina soils (No. 198).—From a few casual observations, the boron problem has developed very extensively. Further evidence has been obtained of the control of excessive wilting of plants and possibly of insect infestation by borax. Field experiments, conducted on a wide range of soil types in the Coastal Plain, suggest the possibility that the most important factor limiting the use of lime is what may be called a boron deficiency. Evidence that under some conditions other elements beside boron will produce similar effects raises a question regarding the specificity of the function of boron in every case.

A disease which is probably identical with alfalfa "yellows" has been controlled on a sandy soil by an application of borax used alone or by a combination of copper, manganese and zinc sulfates. Since the results have been publicized reports have been received of a similar yellowing of alfalfa in the Piedmont and Mountain sections of this state, and also in other states.

This problem extends into the fields of entomology, inasmuch as alfalfa "yellows" has been considered to be associated with leaf-hopper infestation. There may be different types of "yellows", but one of them can be controlled with borax. Further work in entomology will be necessary before the details of the problem can be solved.

Apparently also there is a relation between photoperiodism and the response to boron as no case has been observed in North Carolina of symptoms of acute deficiency occurring during the shorter days. (L. G. Willis and J. R. Piland.)

Stimulative function of organic matter (No. 196).—This project has been discontinued and the results have been published. The evidence is

fairly conclusive that the organic ammoniates, as commonly used in fertilizers, function as sources of active decomposable organic matter. This, in turn, stimulates growth by some mechanism which appears to be the control of the solubility of iron by the stabilization of an oxidation-reduction equilibrium. Copper or manganese promote the reactions involved. (L. G. Willis and J. R. Piland.)

Magnesia deficiencies of some sandy soil types (No. 185).—Mechanical difficulties have seriously impeded the work as outlined. Attention has been given, however, to studies of the "availability" factor of different sources of magnesium and of dolomitic limestone in fertilizers as a source of magnesium for crops. Laboratory tests suggest the use of neutral ammonium citrate as a solvent for "available" magnesium and work on this phase of the problem will be included in the future program.

General applications.—No consistent attempt has yet been made to extend the application of these research results to Piedmont and Mountain soils, but evidence to the workers is accumulating that much of the data on the fertilizer requirement of extensive areas of the Coastal Plain may be in need of drastic revision. Evidences of availability factors and of deficiencies of certain presumably essential elements are also subject to question.

Previous experiments have shown the desirability of limiting the use of lime on many of the soils of the state. It now appears that this is unnecessary and that more liberal liming with the addition of suitable supplements may be desirable and profitable.

It appears to Willis and Piland that one feature of this work as it is applied to lime, is the possibility of extensive expansion of alfalfa production on soils where it has failed heretofore. Boron is apparently the critical supplement, although small amounts of manganese may be desirable. This detail of the work should be of particular value to the livestock industry.

Miscellaneous services to farmers have expanded but these are becoming less of an impediment to research. Many cases reported from farms appear to bear directly on problems under investigation. This gives an opportunity for testing theories under a wide range of conditions. It is encouraging to note that many farmers have been able to adopt new methods which have been demonstrated by this phase of the experimental work before the latter has been completed for publication. (L. G. Willis and J. R. Piland.)

Laboratory Investigations on Inherent Soil Properties Affecting Erosiveness and Fertility of Soils (No. 195).—Previous investigations have shown that two important factors contributing to the erosiveness of soils are (1) the hydrated and (2) the dispersed condition of the colloidal fraction. Several of the soils used were known to contain a high percentage of total iron and some of this had precipitated as iron concretions indicating free iron. These soils appeared to be more highly granulated and less hydrated than those which were known to be low in total iron. Investi-

gations of the relation of the amount of free iron to aggregation show a positive correlation as is seen by the data given in the following table:

Soil Type	A Horizon		B Horizon	
	Percent free Fe2O3	Percent silt-clay aggregated	Percent free Fe2O3	Percent silt-clay aggregated
Alamance silt loam.....	.524	25.6	-----	-----
Georgeville clay.....	3.975	72.4	4.313	55.0
Iredell sandy clay loam.....	4.090	66.0	4.820	74.0
Cecil fine sandy loam.....	4.736	28.2	5.020	72.0
Davidson clay.....	5.059	83.0	5.331	92.
Davidson clay, No. 2.....	-----	-----	5.476	83.3

The free iron probably serves a dual purpose, the part which is in solution functioning as a flocculating agent, and the other as a cementing agent. At the pH of these soils as they commonly occur most of it would be precipitated as a hydrated iron gel which, upon dehydration, would become a good cementing agent. The iron, therefore, not only produces flocculation but cements the particles into fairly stable granules.

To determine the effect of iron on the hydration of clays bentonite suspensions, containing practically no iron were used, and known amounts of iron were added. The iron was added as ferric chloride, the chloride washed out and iron determined in the washings. Swelling determinations were made of the dried Fe-bentonite and it was found that the greater the amount of iron, the less the swelling. The water of hydration was calculated from viscosity determinations of the suspensions. The amount of water associated with each gram of clay was greatly reduced by the smaller additions of iron, but iron in excess of the absorption capacity caused flocculation and occluded water was included in the calculated values. The reductions in some cases were as high as 80 per cent. (J. F. Lutz.)

II. FARM ENTERPRISES

The Organization and Management of Farm Operated by Cropper Labor.

—This project has been in progress since 1928, when a farm survey was made of 112 farms located in Wayne, Pitt, Lenoir, Halifax, and Edgecombe counties. In 1931 and 1935 resurveys were made of the farm business of the preceding year for as many of the original farms as possible. Fifty-nine farm record books were obtained from 22 of the farm owners for their 1934 farm business. In addition to the survey records obtained in 1935, supplementary schedules were obtained from 73 farm owners and 194 croppers. The records taken in 1935 were similar to those taken from the 1928 crop year.

The data collected for each of these surveys have been tabulated and some analysis has been made. Further analysis of the material will be made during the coming year. This study will reveal the changes that

have taken place in the organization and management of the farms under the Adjustment Program, and will shed some light on the changes which have taken place in the status of the cropper. (G. W. Forster and R. E. L. Greene.)

SUMMARY OF THE FARM BUSINESS IN EDGECOMBE, LENOIR, PITT AND WAYNE
COUNTIES IN 1928, 1930, AND 1934

(Average Per Farm)

	1928	1930	1934
Total Number of Farms.....	110	59	71
Land:			
Cropland.....	167	138	146
Tillable land lying out.....	10	9	20
Rotation and open pasture.....	6	7	10
Woods pastured and not pastured.....	167	135	160
Other land.....	16	12	13
Total.....	366	301	349
Capital:			
Real estate.....	\$ 24,400	\$ 18,522	\$ 21,955
Livest ck.....	1,311	1,081	1,300
Machinery.....	948	677	684
Feed supplies.....	740	726	703
Cash to run the farms.....	2,505	1,319	-----
Total.....	\$ 29,904	\$ 22,325	\$ 24,642
Financial returns:			
Total farm receipts.....	\$ 11,073	\$ 5,318	\$ 10,014
Total farm expenses.....	8,315	5,034	6,451
Farm Income.....	\$ 2,758	\$ 284	\$ 3,563
Interest on investment @ 5%.....	\$ 1,495	\$ 1,116	\$ 1,323
Labor Income.....	1,263	-832	2,331
Value of operator's labor.....	979	593	723
Return to capital.....	1,779	-309	2,840
Percent return to capital.....	6.0	-1.4	11.5

A study of dairy cattle as a supplementary enterprise to cotton farming in the Piedmont Section of North Carolina.—This study has been conducted jointly by the Dairy Husbandry, Agronomy, and Agricultural Economics Departments since 1928. The purpose is to show the value of a systematic crop rotation and to obtain information regarding dairying as a supplement to cotton production. A separate field on the Central Experiment Station farm, a section of the cow farm, a separate silo, and eight cows are being used for this project. The field is divided into seven four-acre plots. One plot is kept in continuous cotton and a systematic crop rotation is followed on the other plots. The table below gives the rotation followed at the present:

CROPPING PLAN—DAIRY-CROP UTILIZATION PROJECT

Field No.	1st Year	2nd Year	3rd Year
1*-----	Cotton	Corn (2)	Hay (1)
2-----	Cotton	Corn (2)	Hay (1)
3*-----	Hay (1)	Cotton	Corn (2)
4-----	Hay (1)	Cotton	Corn (2)
5*-----	Corn (2)	Hay (1)	Cotton
6-----	Corn (2)	Hay (1)	Cotton
7-----	Cotton	Cotton	Cotton

*These fields to receive manure applications ahead of corn crop.

(1) Hay Crop—Lee oats, followed by Tennessee 76 lespedeza.

(2) Cover crop ahead of corn—Rye, vetch, crimson clover.

The Department of Agricultural Economics posts the monthly labor and cost data and at the close of each year prepares a summary statement showing the cost of each crop produced, the cost of producing milk, and also the cost of maintaining the dairy herd. The department also renders assistance to the other cooperating departments in developing ways and means of reducing costs, and in conducting the experiment in such a way as to reflect actual farm operations. A summary of the operations of the experiment has been prepared for each year from 1929 to 1936, inclusive. No crops were produced in 1933 because the land was divided into a new field arrangement, and this was completed too late for any crops to be grown. The following table shows the yield per acre of various crops since the project was started in 1928. (R. E. L. Greene and C. D. Grinnells.)

A study of peach orchard management.—This project, which has been active since 1927, has been completed, and the results will appear soon in a Station bulletin. For a statement of the objectives and summary of the findings the reader is referred to the Fifty-seventh Annual Report of the North Carolina Agricultural Experiment Station. (G. W. Forster and R. E. L. Greene.)

A study of farm organization and soil management practices in North Carolina in relation to agricultural conservation and adjustment with special reference to formation of programs under the Soil Conservation and Domestic Allotment Act.—This study was sponsored by the Program Planning Division of the Agricultural Adjustment Administration in co-operation with the Division of Farm Management and Cost and the Soil Conservation Service of the United States Department of Agriculture and the Departments of Agricultural Economics and Rural Sociology and Agronomy of the North Carolina Agricultural Experiment Station.

The objects of this study are: (1) To study farm organization, operation, and extent of erosion in two typical areas of North Carolina to determine (a) the effect of cropping systems and farm practices on soil erosion, soil depletion, and economic farm operations; (b) the relation of prevailing farm practices to needed adjustments in the area, and the cost and need of practices effective in controlling erosion and soil depletion. (2) To revise the recommendations made in connection with the

YIELD PER ACRE OF CROPS—DAIRY UTILIZATION PROJECT

Year	Silage Corn		Cotton		Cotton		Soybean Hay		Lespedeza		Corn		Oat Hay	
	Field No.	Yield	Field No.	Yield	Field No.	Yield	Field No.	Yield	Field No.	Yield	Field No.	Yield	Field No.	Yield
		(tons)		(lbs.)		(lbs.)		(tons)		(tons)		(bus.)		(tons)
1929	1	3.0	3	280	4	289	2	1.7						
	5	2.4	7	250			6	2.2						
1930	3	4.2	2	256	4	236	1	.89	1	.70	3	23.2		
	7	4.4	6	218			5	.79	5	.80	7	20.0		
1931	2	5.1	1	467	4	501	3	1.1	3	1.1	2	7.4		
	6	4.1	5	507			7	1.0	7	1.0	6	5.3		
1932	1	2.0	3	281	4	244	2	.37	2					
	5	2.3	7	256			6	.24	6					
1934	5	4.3	1	421	7	346			3	1.78	6	8.4	3	.74
			2	437					4	52*			4	.77
1935	1	4.2	3	369	7	321								
			4	261					5	1.7	2	13.9	5	1.04
1936	3	7.4	5	484	7	413			6	78.*			6	18.0**
			6	440					1	1.4	4	16.2	1	1.0
										126*			1	27.0**

*Lespedeza seed per acre in lbs.

**Yield of oats for grain per acre in bushels.

Regional Adjustment Project of 1935 for the two areas studied, and, so far as the results of this study are applicable, to revise the recommendations for the other areas in the state in order to provide a better basis for planning and administrating the Agricultural Conservation Program. And, (3) To test the effect of present landlord-tenant relationships and the distribution of benefit payments between the landlord and tenant on soil conservation.

One hundred and seventy-two farms were surveyed in Franklin county, and 136 farms in Wilson county. Two schedules were obtained for each

FARM BUSINESS SUMMARY, FRANKLIN AND WILSON COUNTIES, 1935
(Average Per Farm)

Item	Franklin County	Wilson County
Total Number of Farms.....	172	136
Land:		
Acres in Crops.....	42.7	39.0
Acres in other land.....	91.6	43.1
Total acres operated.....	134.3	82.1
Capital:		
Real estate.....	\$ 4,508	\$ 6,130
Livestock.....	409	419
Machinery.....	127	158
Feed and supplies.....	144	203
Cash to run farm.....	319	312
Total.....	\$ 5,507	\$ 7,222
Total Farm Receipts.....	\$ 1,947	\$ 3,138
Total Farm Expenses.....	1,137	1,720
Farm Income.....	\$ 810	\$ 1,418
Interest on capital @ 5%.....	\$ 275	\$ 361
Labor Income.....	\$ 535	\$ 1,057
Value of operator's time.....	286	326
Return on capital.....	524	1,092
Percent return on capital.....	9.5	15.1

farm—one schedule was used to obtain economic data on farm organization and management, and the other schedule to obtain a record of land use practices which affect soil conservation, including data on cost and effectiveness of these practices in controlling soil erosion and soil depletion. The Soil Conservation Service made a detailed map of each farm surveyed showing land use, classification of soil, extent of erosion, and degree of slope according to their standard mapping procedure.

Franklin and Wilson counties were chosen for this study because they are representative of two of the main tobacco areas of North Carolina.

Most of the cultivated land is in row crops, and at present little attention is being paid to crops for soil maintenance conservation.

As prices of tobacco were reasonably favorable in 1935, on the average returns were fairly satisfactory. However, adjustments in the cropping plan are seriously needed. Part of the acreage in row crops and clean cultivated crops should be replaced by crops for soil improvement and soil maintenance and conservation. Summarized below are a few of the important items of the farm business.

Most of the data have been tabulated and analyzed. A report was submitted to the Program Planning Section in Washington summarizing mainly the information on cropping practices. Another report summarizing the farm business information is almost completed at the present time. A mimeographed summary will be issued soon on this. (Cooperation Agricultural Adjustment Administration and Bureau of Agricultural Economics, R. E. L. Greene and Olaf Wakefield.)

The effect of a definitely planned soil conservation program on the operation of farms in Franklin county.—Economic phase: In January, 1937, the Department of Agricultural Economics and Rural Sociology, in cooperation with the Soil Conservation Service and the Bureau of Agricultural Economics of the United States Department of Agriculture, began a five-year project to determine the social and economic effects of demonstration methods in soil conservation. The area being studied in the Cedar Creek Soil Conservation Demonstration Project Area, located in Franklin county.

The objective of the economic phase of this project is to determine the effects of a definitely planned program of soil conservation upon farm organization, farm practices, crop and livestock, production costs, and farm income. To effect this objective, data are being obtained from farm business records and daily farm labor records, which are kept by farmers under the supervision of field men. From the beginning of the field work in March approximately 100 farmers are keeping farm business records, which contain such items as major land use, cropping system, crop and livestock production, income, expenditures, and inventory of all farm assets at the beginning and end of each year. Data on labor requirements and distribution are being obtained from fifty farmers. In order to correlate labor requirements with various soil conservation practices, the labor data are obtained by crops and, insofar as possible, by fields.

A previous study made of farm organization and soil conservation practices on 172 farms in this area in 1935 and 1936, in cooperation with the Agricultural Adjustment Administration, shows the conditions preceding the program inaugurated by the Operations Division of the Soil Conservation Service. Data are being collected this year on as many of these farms as possible in order to record changes due to the Soil Conservation Program. For purposes of comparison, data are being obtained from farmers cooperating with the Operations Division of the Soil Conservation Service and from a group of non-cooperators. (Cooperation Soil Conservation Service, Bureau of Agricultural Economics, S. W. Atkins.)

RESULTS OF SOIL FERTILITY INVESTIGATIONS ON BRANCH STATIONS

At Upper Coastal Plain Station (Norfolk sandy loam and Okenee fine sandy loam). A study of the utilization of crops grown in rotation by two different methods No. 9.—This cooperative experiment with the Animal Husbandry Department was inaugurated in 1937 to compare crop yields, financial returns and fertility of the soil under two methods of crop utilization. The experiments consist of three one-acre plats grown to a three-year rotation of (1) corn, soybeans; (2) cotton with rye and crimson clover; and (3) soybeans with rye and crimson clover. Plat No. 1 is fertilized normally and all cover crops are turned under for soil improvement. Plat No. 2 is fertilized the same as No. 1, but all crops, except cotton, are "hogged off". Plat No. 3 is "hogged off" the same as No. 2, but in fertilizing 80 per cent of the fertilizing value of supplementary feeds given to the hogs is deducted from the normal fertilization. While the hogs were hogging off crops grown on plats Nos. 2 and 3, they were fed a supplemental ration of fish meal, cottonseed meal and mineral mixture. The yields of corn in 1936 were obtained by harvesting the entire area of plat No. 1, and nine 50-foot sections of plats Nos. 2 and 3, and the yields were calculated to the acre basis. The yields were 33 bushels for plat No. 1; 51.2 bushels for plat No. 2; and 37.8 bushels for plat No. 3. The net returns from the different cropping systems of the three plats have not yet been worked up.

It required 6 pigs 63 days, and 12 pigs 10 days to consume the corn from plat No. 2. In addition to the feed grown on Plat No. 2, the pigs were fed 151 pounds of fish meal, 151 pounds of cottonseed meal, and 17 pounds of mineral mixture. The total gain, or amount of pork produced per acre with the additional supplementary feed was 947 pounds.

The feed from plat No. 3, plus 240 pounds of a mixture of equal parts fish meal and cottonseed meal and 14 pounds of mineral, carried 6 forty-six pound pigs 63 days and caused them to gain a total of 795 pounds per acre. (Earl H. Hostetler and E. R. Collins. Cooperation Departments of Animal Husbandry and Agronomy.)

Fertilizer and lime requirements for corn and soybeans grown in rotation, the soybeans being utilized for seed production in one series and for hay production in another.—This experiment is being conducted to determine the best fertilizer for corn, soybeans (for seed); and soybeans (for hay); and to show the effect upon succeeding crops of corn where the soybeans are picked for seed versus cutting them for hay. Consistently much higher yields of corn have been obtained where the soybeans were picked for seed than where they were harvested for hay. (C. B. Williams, E. R. Collins and R. E. Currin, Jr.)

Study of yields and quality of succeeding crops when cotton, corn, small grain and peanuts are grown continuously and when they are combined in two, three and four-year rotations.—This experiment was inaugurated in 1924 and is a study of the yields and quality of succeeding crops and their effect upon the fertility of the soil when cotton, corn, peanuts and small grain are grown continuously and when they are combined in two, three and four-year rotations.

In 1927 the plats were divided; the north series received normal fertilization for each crop, while on the south series they were each fertilized so that all the rotation plats received the same amount of plant food in the complete rotation as the continuously cropped plats.

In 1936 the four-year rotation in the north series produced 54.3 bushels of corn compared to 30.3, 32.2 and 33.7 bushels on the continuously cropped plats. In the south series the four-year rotation produced 54.9 bushels of corn compared to 47.1, 36.4, and 32.5 bushels on the continuously cropped plats. (C. B. Williams, E. R. Collins and R. E. Currin.)

At Mountain Station (Porters loam and Toxaway loam)—Fertilizer requirements for corn, wheat and soybeans when grown in a three-year rotation on Toxaway loam (Field A).—The yield records of wheat from this experiment in 1936 add further evidence to previous findings; i.e., more economical yields of crops have been produced from the use of a complete fertilizer, with lime once in the rotation, than from single elements or combinations of two elements. (C. B. Williams, W. H. Rankin and S. C. Clapp.)

Comparative value of rock phosphate, superphosphate, soft phosphate and basic slag as sources of phosphoric acid when used on Toxaway loam for corn, wheat and soybeans grown in rotation.—Superphosphate has been found to be the most efficient source of phosphoric acid in this experiment; i.e., where lime is applied once in the rotation, where no lime is applied, and where stable manure is used as the source of nitrogen. (C. B. Williams, W. H. Rankin and S. C. Clapp.)

A study of different fertilizer treatments and methods of utilizing the legumes when grown in a three-year rotation on Porters loam (Field R).—In this experiment where one crop of corn, one soybean crop, one wheat crop and one lespedeza crop has been grown the indications are thus far that if all the legume crops are removed, as has been done on half of each plat, the yields of all crops are reduced. If, on the other hand, all the legumes, both soybeans and lespedeza, are returned to the soil after growth, the yields of corn and wheat are increased, provided all crops receive complete fertilizers. On the plats that have not received complete fertilizers, the yields of corn and wheat are not being maintained. (C. B. Williams, W. H. Rankin and S. C. Clapp.)

At Piedmont Branch Station (Cecil clay Loam)—Fertilizer and lime requirements for cotton, corn, wheat and red clover grown in rotation (Field A and B).—The rotation used in this experiment was amended by adding lespedeza in the seeding with red clover on Field B during the spring of 1936. The red clover was harvested in the spring of 1937 allowing the lespedeza to make more growth to be returned to the soil, supplementing the second growth of red clover. The lespedeza appears to be a very satisfactory supplement to the red clover.

The response to fertilizers on these two fields have been found to be similar to that of previous years. Red clover fails without lime and produces larger yields with complete fertilizers which contain higher percentages of phosphoric acid. Higher corn and wheat yields are produced on the same plats that produce the best yields of clover. This is probably

a secondary effect in that with a satisfactory growth of red clover, there is more organic matter and nitrogen returned to the soil for the corn and wheat crops. Where potash is omitted or the percentage is very low in a complete fertilizer that is applied to red clover, the stand of clover is inferior and the plants that survive show potash deficiency symptoms. (C. B. Williams, W. H. Rankin and J. W. Hendricks.)

A comparison of rock phosphate with superphosphate as a source of phosphoric acid on Cecil clay loam in a rotation of corn, wheat and red clover (Field G).—When equal amounts of phosphoric acid are applied from rock phosphate and superphosphate for crops in this rotation, the yields produced from superphosphate are larger than are secured from rock phosphate. Where increasing quantities of rock phosphate have been applied, the stand of red clover has been reduced correspondingly and symptoms that are corrected or prevented by the use of potash are prevalent both on the plats that have received lime and those that have not. (C. B. Williams, W. H. Rankin and J. W. Hendricks.)

Yield and quality of crops when grown continuously and in rotation (Field D).—It has been found that the yield of corn grown in a three-year rotation with wheat and red clover was three times as great as was secured from the corn grown continuously, both having received the same fertilizer treatment. (C. B. Williams, W. H. Rankin and J. W. Hendricks.)

At Central Station (Cecil sandy loam)—Comparison of relative values of superphosphate, colloidal phosphate and basic slag as carriers of phosphoric acid in the production of cotton (Field X).—When the same amounts of phosphoric acid are applied from each of these three sources of phosphoric acid, superphosphate produced more cotton than did either of the other two sources of phosphoric acid. (C. B. Williams and W. H. Rankin.)

At Coastal Plain Station (Dunbar fine sandy loam)—Fertilizer and lime requirements for crops grown in a three-year rotation of corn; oats and vetch, soybeans (turned); and soybeans (seed) (Field A).—The yields of oats and vetch for 1936 correspond very closely to the yields of 1933. The quality of the hay was superior on the limed plats, in that the percentage of vetch in the hay was greater. Manganese sulfate was added at the rate of 50 pounds per acre broadcast to half of all the plats that had received lime once in the rotation and which had developed a severe manganese deficiency. This deficiency was only partially corrected by the application. (C. B. Williams, W. H. Rankin and Chas. Dearing.)

The effect of a definitely planned soil conservation program on the operation of farms in Franklin county.—This is a cooperative project with the Department of Agricultural Economics and the report from the Agronomy Department deals only with the soil management practices.

Farm business and farm practice records were taken on 172 farms in Franklin county, and on 136 in Wilson county. Farm maps were available for practically all of the farms but for the few farms that were not mapped the practice schedules were incomplete. These maps showed, in addition to cultural features, four important items, namely: (1) degree of erosion, (2) slope, (3) land use, and (4) soil type.

The practice schedule provided for data on the following vegetative, engineering and soil management practices:

1. Terracing
2. Other engineering practices
3. Pasture establishment and treatment
4. Reforestation
5. Cover crops
6. Rotations
7. Strip-cropping
8. Contour tillage
9. Fertilizer use
10. Relation of crops to
 - a. Soil type
 - b. Degree of erosion
 - c. Slope
 - d. Etc.

Using these and the farm business data as a basis, farming systems were recommended for typical farms from each project area. General recommendations were then made for the project area of the two counties. These data and a classification of the soils, by counties of the State, as to the cultivated areas adapted to various crops, are being used as a basis for making county and crop area recommendations for the entire state. (C. B. Williams and J. F. Lutz, cooperation Department of Agricultural Economics.)

Fertilizer and lime requirements of crops grown in rotation (Field E).—The yield records from this experiment show that the fertilizer requirement of the crops cannot be met by adding to the crops annually the same amounts of nutrients removed by the crops. (C. B. Williams, W. H. Rankin and Chas. Dearing.)

At Blackland Station (Muck)—Rock phosphate, superphosphate and basic slag compared as sources of phosphoric acid when corn, oats, soybeans (turned) and Irish potatoes; soybeans (turned) are grown in a three-year rotation.—The records of this experiment show that all crops in the rotation respond more to potash than they do to either nitrogen or phosphoric acid. The use of phosphoric acid from any of the above sources causes a reduction in yield of the crops. However, basic slag was less injurious to crop growth than the use of the other two phosphatic carriers of phosphoric acid.

In the fall of 1935 an application of 50 pounds of copper sulphate was applied broadcast per acre to half of the three sections of this experiment. During the following spring oats showed a marked response to the copper sulphate application, but the corn and Irish potatoes did not. (C. B. Williams, W. H. Rankin and J. L. Rea, Jr.)

A study of the rates and forms of lime for corn, with and without fertilizer (Field L).—The 1936 yields add further substantiating evidence to findings of previous years that ground dolomitic limestone is a more efficient source of lime for corn grown on muck soil than is either hydrated lime or marl.

A complete fertilizer used in addition to the lime produced a very satisfactory increase in yield, while a complete fertilizer without lime produced less than did the use of lime alone. The plats which have had no lime are

practically barren, due to excess acidity of the soil. (C. B. Williams, W. H. Rankin and J. L. Rea, Jr.)

Fertilizer and lime requirements for corn and soybeans grown in rotation, the soybeans being utilized for seed in one series and for hay in the other.—Soybeans were grown on this experiment in 1936. The results secured add further evidence to that already secured that potash is very important and that the best yields were obtained from those plats which had received the higher applications of potash, very low amounts of phosphoric acid, and relatively low amounts of nitrogen. (C. B. Williams, W. H. Rankin and J. L. Rea, Jr.)

Phosphate Experiments in Cooperation with Tennessee Valley Authority Phosphate Experiments.—Experiments have been conducted since 1935 on nineteen fields comparing the relative efficiency of several high analysis phosphates. The treatments used were 400 pounds per acre of a 4-10-4 mixture for all crops in the mountain areas and for all in the Piedmont area, except cotton which received 600 pounds per acre of the same mixture. In the Coastal Plain, 400 pounds of a 4-8-4 mixture was used for corn, and 600 pounds per acre of the same mixture for cotton. Cotton and corn in the Coastal Plain and Piedmont received in addition 15 pounds of soluble nitrogen as a side application.

The phosphates compared are: Ammoniated monocalcium phosphate, ammoniated superphosphate, monocalcium phosphate, dicalcium phosphate and tricalcium phosphate. Sources of nitrogen used with each phosphate are: Nitrate of soda alone, sulphate ammonia alone, and a mixture of one-half from nitrate of soda and one-half from sulphate of ammonia. Each experiment included one no fertilized check plat, and one standard mixture plat (16 per cent superphosphate, nitrogen: one-half from sulphate of ammonia, one-fourth from nitrate of soda and one-fourth from cottonseed meal). Muriate of potash was the sole source of potash throughout the experiments.

These experiments are laid out in duplicate, one series receiving 500 pounds of ground dolomitic limestone per acre as a filler, and the other series being made up without filler.

The experiments included nine fields with corn, wheat and lespedeza in rotation; five with corn and cotton in rotation; four with grasses for hay; and one with pasture grasses.

Results with corn—In the Mountain area (average of nine fields) monocalcium phosphate produced the highest yields in both series. The average increase for fertilization was 47.7 per cent for the unlimed series, and 50.2 per cent for the limed series. There was little difference between the average total yield of the two series.

In the Piedmont and Coastal Plain areas (average of eight fields) monocalcium phosphate produced the highest yield in the unlimed series, tricalcium phosphate and dicalcium phosphate produced the highest in the limed series. The average increase for fertilization for the unlimed series was 83.8 per cent, and for the limed 97.7 per cent. The total average yield for the two series was almost identical.

Nitrate of soda alone as a source of nitrogen gave an increase over sulphate of ammonia of 18 per cent in the unlimed series, and 15.8 per cent in the limed series.

Results with Hay—(average of four fields).—Ammoniated monocalcium phosphate produced the highest yield in both series. Fertilization increased the yield 37.6 per cent in the unlimed series, and 47.7 per cent in the limed series.

Results with pasture (one field).—Monocalcium phosphate produced the highest yield. The unlimed series produced an average increase over the limed series of 122 pounds (dry weight) per acre. Analyses are now being made of samples taken at each cutting. (W. W. Woodhouse.)

Triple superphosphate experiments.—In 1935 four experiments were started comparing triple superphosphate with superphosphate using various fillers, namely: Dolomitic limestone, gypsum, granular calcium silicate slag and ground calcium silicate slag. The sources of nitrogen with each phosphate and filler are nitrate of soda alone, sulphate of ammonia alone, and a mixture of the two. Muriate of potash is the sole source of potash.

These experiments include two fields with cotton and corn in rotation and two with corn, wheat and lespedeza in rotation.

Results with Corn.—In the piedmont triple superphosphate with granular calcium silicate slag as a filler produced the highest yield.

In the Coastal Plain triple superphosphate with gypsum as a filler produced the highest yield. On this experiment nitrate of soda produced an average increase over sulphate of ammonia of 13.3 per cent.

Results with lespedeza.—As the lespedeza was grown for soil improvement and turned under no weights were obtained. No consistent differences were noted except the better stand and growth was obtained where phosphate was used. (W. W. Woodhouse.)

Fused phosphate experiments.—Two experiments were started in 1936 comparing fused phosphate with 16 per cent superphosphate. These were located in the Piedmont and Coastal Plain areas with corn and cotton in rotation.

With corn, the fused phosphate produced yields about equal to those produced by superphosphate. (W. W. Woodhouse.)

INVESTIGATIONS WITH TOBACCO

Tobacco Branch Station.—The Tobacco Station and its equipment is owned by the North Carolina Department of Agriculture and is operated jointly by the North Carolina Department of Agriculture, United States Department of Agriculture and the North Carolina Agricultural Experiment Station. This station is located about one mile west of Oxford on the Oxford-Stem highway.

The primary object of the research work being conducted at this Station is to improve the fertilization of the tobacco crop, cultural methods, methods of applying fertilizers, crop rotations, varieties, curing methods and diseases. Only the agronomic phases of the work are being considered in this report.

Tobacco variety test for yield, quality and type (No. 46).—Satisfactory progress has been made in the work on this project. Selections have been made which indicate better yield and quality can be obtained. The Cash, White Stem Orinoco, Bonanza, Jamaica and Gold Dollar have been found

to be the best varieties for the Middle and Old Belts. In the New Belt, Gold Dollar, Virginia Bright Leaf, Bonanza and White Stem Orinoco are the varieties most favored. (E. G. Moss and J. F. Bullock.)

Crop rotations (No. 47).—The influence of preceding crops upon yield and quality of tobacco is of more importance than was at one time recognized. Various crops not only influence yield and quality of the cured leaf, but are of considerable importance in the control of disease. This is particularly true of such diseases as Granville wilt, root-knot, and black shank. It is also of great importance in the proper fertilization of the tobacco crop. In areas where Granville wilt is not prevalent, a weed crop is one of the best crops to precede tobacco; however, such a rotation which allows weeds to grow cannot be used in areas where the Granville wilt is present. (E. G. Moss.)

Sources of nitrogen experiment for tobacco (No. 48).—A number of sources of nitrogen have been used in crop tests and efforts have been made to measure the relative differences of the different nitrogen carriers. Soybean meal has been one of the few organic sources which has shown up reasonably well. If and when this product can be bought cheaply enough to be used in the fertilizer mixture, the indications are that it will be very satisfactory. While there may not be such marked differences between sources of nitrogen, at the same time it certainly seems worth while to use more than one source of nitrogen in fertilizer mixtures for tobacco. (E. G. Moss.)

Sources and amounts of potash (No. 49).—Several sources of potash have been used in this experiment during the past few years and recently the rate has been more widely varied than was done heretofore. A series of plats containing from 30 to 300 pounds of potash (K_2O) per acre has been run. The results thus far obtained very definitely indicate that considerably more potash can be used to advantage than has been done by growers in the past. Both yield and quality have been progressively improved up to around 250 pounds of potash (K_2O) per acre with the indication that the curve of improvement would straighten when amounts above this amount are used. Apparently there is not so much difference between the sources of potash, provided, however, that too much chlorine is not added. On some soils above 20 pounds of chlorine per acre appeared to injure both quality and yield, while on the stiffer soils 30 pounds was found could be used with safety. (E. G. Moss.)

Fertilizer tests with calcium, magnesia, sulphur and chlorine (No. 50).—Small amounts of magnesia (20 to 30 pounds of MgO per acre) appear to benefit both yield and quality on the majority of soils, even on new land which has just been cleared. Little can be said at present as to the proper amount of sulphur that is necessary for best results. There are indications that very heavy amounts of SO_3 have a tendency to darken the color of the cured leaf and reduce its selling price. Just to what extent and where the point of change is has not been determined definitely. In regard to chlorine, apparently there is no question that large amounts of chlorine influence unfavorably the burning quality of the cured leaf and injure the growth where excessive amounts are used. On

the other hand, small amounts of chlorine (20 to 30 pounds per acre) seem to give a slightly better texture and larger yields. (E. G. Moss.)

Fertilizer tests of tobacco in rotation with oats, soybeans and rye (No. 51).—These tests consisting of 72 plats, one-half of which had previously been limed with a total of three tons of ground dolomitic limestone per acre, have been continued since 1911 with changes being made from time to time in the base application of the fertilizer. On the limed end of these plats, which has encouraged the growth of wild legumes and other vegetation, plats are beginning to show that too much nitrogen is available for the best quality of tobacco. The indications are the base fertilizer (800 pounds of a 3-8-6 mixture) will have to be changed, reducing the nitrogen and increasing both phosphoric acid and potash. The tobacco on plats which had 18 per cent potash during the 1936-1937 season produced very much better quality of tobacco than where only 6 per cent of potash was used. (E. G. Moss.)

Tobacco after soybeans (No. 58).—The object of this experiment is to see if a proper balance of fertilizer can be used after soybeans, turned under, to grow quality tobacco. Varying amounts of phosphoric acid and potash, with and without sulphur, have been applied. No commercial nitrogen has been used on a part of these plats. The results up to the present indicate that such a practice could not be recommended, only in exceptional cases. The indications also are that it would require three to four times as much potash as is usually recommended in general farm practices. (E. G. Moss.)

Sulphur and chlorine studies (No. 59).—This test was designed to study in more detail the effect of heavy applications of sulphurtrioxide (SO_3) in the form of sulphates on the tobacco. Nothing very outstanding has been secured from these tests so far. (E. G. Moss.)

Plant bed fertilizer studies (No. 60).—Comparatively little work has been done on the fertilization of tobacco seed beds. For the past three years different fertilizers have been used in a comparative study of this matter. The results obtained by the use of all nitrate of soda as a source of nitrogen applied at the time of planting the seed bed has been very unsatisfactory. The indications are the nitrogen, applied in this form, has leached out before the plants were large enough to take it up. There may be, however, some other factor which is at present unknown. Soybean meal has been one of the sources of nitrogen which has given good results. Chlorine in the mixture is not advisable. (E. G. Moss.)

Tobacco curing experiments (No. 61).—For the past three or four years limited studies have been made on methods of curing tobacco. Temperature and humidity records have been kept. Studies on air control and different fuels have been carried on. At the Station an electrically equipped barn was used for the first time, and so far as information is available, it is the first time flue-cured tobacco has ever been cured out by the use of electric current to supply the heat. The results secured indicate that tobacco can be successfully cured in this manner, and the temperature can be controlled very efficiently. The major draw back, however, will be the cost of the current. Fuel oil burners were used in another barn, and

in another barn a stoker was used for the past three seasons. These methods have been compared with the ordinary wood furnaces.

The most efficient in fuel consumption has been the coal stoker. The six curings during the past season were finished at an average of less than 1100 pounds of coal for each curing. Regular stoker coal was used at a cost of \$7.50 per ton delivered at the Station. This cost can be slightly reduced by buying coal in carload lots.

The oil burners were very satisfactory but the cost so far has been slightly greater than wood, averaging between \$8.00 and \$9.00 per barn. No definite statement so far can be made with reference to the cost of electric current, since there has been no established rate for current for this purpose. The stoker barn and the electrically equipped barn were thermostatically controlled, which, of course, reduces to a minimum the cost of labor in the curing process. One definite conclusion which has been reached so far is that ventilation is one of the important factors in the curing process. The average wood barn will consume from one and a half to two cords of wood for each curing. (E. G. Moss.)

Upper Coastal Plain Branch Station—Variety and strain test.—After testing several of the varieties most commonly planted in this section, we find that Station Strain No. 1, Virginia Bright Leaf and Gold Dollar lead in value per acre. Bonanza and Hickory Pryor show up very well also. (R. E. Currin, Jr., and J. P. Young.)

Best source or sources of potash for tobacco.—As a single source, high grade muriate gives a better yield and color. One-half muriate and one-half sulphate of potash-magnesia leads in value per acre, where 50 pounds of K_2O is used per acre. (R. E. Currin, Jr., and J. P. Young.)

Effect of fractional applications of fertilizer on the quality and yield of tobacco.—On fairly heavy soil and with normal rainfall no benefits were secured by splitting the applications or from additional applications of quick acting nitrogenous material or combination of nitrogen and potash. In some instances additional applications gave some damage to quality. On light, sandy soils five to ten pounds of quick acting nitrogen and 50 to 100 pounds of K_2O applied not over twenty days after planting gave good results. (R. E. Currin, Jr., and J. P. Young.)

Test with calcium, magnesium, sulphur and chlorine for tobacco.—So far in these tests, the only element that seems to be lacking in sufficient quantity is magnesium. No seeming damage occurred with fairly heavy amounts of sulphur and chlorine where the soil contains sufficient calcium. Some of these plats show considerable potash deficiency where only 50 pounds of K_2O was used per acre. (R. E. Currin, Jr., and J. P. Young.)

Curing test with coal stoker.—Wherever electric current can be had it is found that the use of the coal stoker method of curing is very economical. It is found under normal conditions that one can cure 600 to 800 sticks of tobacco with a fuel cost of about \$3.50 with coal costing \$6.00 per ton. The insulation cost will run from \$150.00 to \$200.00 per barn, the cost depending upon the distance from a power line. (R. E. Currin, Jr., and J. P. Young.)

A study of soil treatment for the control of Granville Wilt caused by *Bacterium solanacearum*.—The Granville Wilt of tobacco was severe during the year and has appeared in many new areas throughout the eastern part of the state.

Studies were continued on Granville and Durham soils that were treated in 1935 with various chemicals. Copper sulfate treated soil continued to stunt the tobacco and there was partial control of wilt where 500 pounds to the acre was used. The 1000 pounds to the acre application showed much less toxicity than during the two previous years. This large amount did not control the disease entirely, but it greatly reduced infection. It is apparent, however, that any strength that will control the disease will be seriously toxic to the plant.

During 1936 a very favorable control of the disease was obtained on soil treated the previous season with sulphur and lime, each at the rates of 600, 800 and 1000 pounds to the acre. The disease was suppressed on these plots again in 1937, but the plots had become reinfected to the extent that losses were heavy. Sulphur and lime each applied at the rates of 800, 1000 and 1500 pounds to the acre in March on Granville, Norfolk and Durham soils caused severe injury, indicating that applications made in the same season of the planting are certain to be unsatisfactory. Significant control was obtained on plots which received 400 pounds of sulphur and 1000 pounds of lime to the acre in 1935 and 1000 pounds of ferrous sulphate to the acre in 1936. The plants on these plots were stunted slightly throughout the season but finally produced a fair yield of tobacco. There was no control on soil that was treated in both 1935 and 1936 with ferrous sulphate at the rates of 1000, 2000 and 3000 pounds to the acre. The soil treated with manganese sulphate at the rate of 1000 pounds to the acre in 1935 and which had given some indication of having control values, during 1935 and 1936 did not show any control in 1937.

On areas treated with cyanamide at the rates of 500 and 1000 pounds to the acre in 1935 the promising reductions in losses observed in 1935 and 1936 were not obtained in 1937. On soil treated with cyanamide in 1936 there was much less infection and loss than on plots that received general fertilization.

The residual effects of sulfur on the control of wilt were pronounced on Durham sandy soil that was treated in each of the three years 1931, 1933 and 1934. The control was most pronounced on plots that received 400 and 600 pounds to the acre for the three years, but the 200 pound application also showed control values. The land was sown in wheat in the fall of 1934 and weeds grew on the land after the wheat was harvested in 1935. Corn was grown on the land in 1936. In adjacent areas bordering the experimental area the tobacco wilted severely and was nearly a total loss. (R. F. Poole.)

Relation of chemical and soil factors to parasitic diseases of plants, with special reference to Granville Wilt of Tobacco (No. 175).—On January 1, Ralph W. Cummings began work on a cooperative project with the Department of Plant Pathology which is designed to determine the relation of chemical factors to parasitic diseases of plants. The first work was done in the greenhouse in a study of the effect of temporary water-logging of a soil on the susceptibility of plants growing in this soil to

infection with *B. solanacearum*. Tobacco, tomato and dwarf sunflowers were used in greenhouse experiments on Norfolk loamy sand having a moisture equivalent of 7.0 per cent.

The experiments were conducted in one-gallon pots with the introduction of the following variables:

± inoculated with *B. solanacearum*.

± flooding of the soil for two days.

The replication of each treatment was five-fold. The results secured were inconclusive. With tobacco and tomatoes the flooding treatment had apparently little effect on disease development as both the waterlogged and non-waterlogged series developed the disease soon after inoculation of the soil. Waterlogging stunted the tobacco very severely. In the case of sunflowers, however, all the plants in the waterlogged inoculated series developed the disease in the normal period of time, while none of the plants in the non-waterlogged inoculated series came down until after the roots had been injured mechanically. This points to a necessity for root injury for infection of sunflowers by *B. solanacearum*.

Results secured in a later experiment did not seem to require root injury for infection of the plants.

A number of chemical treatments were tried out in other experiments, but no results were secured that gave any indications of promise in overcoming the disease.

It was noted by Mr. Cummings that no appreciable resistance to bacterial wilt of tobacco has yet been observed in plants grown from seed saved from healthy plants occurring in a badly infected field in which most of the plants went down.

The effects of soil treatment on the control of the Black Shank disease of tobacco.—During the past five years various chemicals have been applied to soils heavily inoculated with *Phytophthora nicotianae*, which causes the black shank disease. Copper sulfate applied in the row and broadcast at the rates of 500 and 1000 pounds to the acre had reduced infection only slightly although both strengths were toxic to the plants. Zinc sulfate applied at the rate of 2000 pounds to the acre also slightly reduced infection, but not sufficiently to be of any significant value. Sulfur applied in the row and broadcast at the rates of 200, 400, 600, 800 and 1000 pounds to the acre had brought about good control, but when used without lime resulted in serious stunting of the plants. When an equal quantity of lime is applied with sulfur it becomes apparent that excellent control is also obtained without any impairment in the quantity of the yield and quality. The residual effects three years after application have given even more consistent results than were obtained the first year following the application. On plots that received 1000 pounds each of sulfur and lime to the acre in 1935 there was a perfect stand in 1937, while surrounding untreated plantings were a total loss. The 600 and 800 pound to the acre applications also produced more than 80 per cent stands of healthy plants. These results appear to have valuable practical significance. (R. F. Poole.)

Tobacco mosaic.—In connection with this project a study is being made of survival of the tobacco mosaic virus in soil stored under various environmental conditions. While only preliminary results are available

these indicate that virus is inactivated within a few months when stored in soil at 38° C. In soil stored at 8°, 18°, and 28° C. for 6 months, inactivation was not indicated by the method of testing employed. Storage in soil with a moisture content as low as 5% of its water holding capacity resulted in inactivation of virus within 6 months, but with a moisture content of 10% or above, inactivation was not indicated within this period of time. Virus stored in soil having a pH of 2.94 was inactivated within 6 months but a higher pH up to 8.35 complete inactivation did not occur within this period. When such soils were dried greater inactivation of virus occurred at low pH than at an intermediate pH, or at a pH near the neutral point. Repeated moistening and drying of soil containing mosaic virus brought about greater inactivation of virus than drying once. Three natural soils of the Norfolk series which differed from each other in respect to degree of fineness, differed also in respect to ability to inactivate mosaic virus both upon drying and upon storage in moist condition, the finer soils inactivating the greater amount of virus.

In a population of 266 F₂ plants derived from reciprocal crosses between mosaic resistant Ambalema tobacco and the susceptible White Stem Oronoco variety 249 showed at least a trace of mosaic mottling while 17 showed no visible mottling of leaves. Seed was saved for further testing from the best resistant plants. (S. G. Lehman.)

Studies on southern root rot.—Southern root rot or Southern stem blight is caused by *Scelerotium rolfsii*, a common and widespread soil pathogen. Many important cash crops, including tobacco, peanuts, pepper, sweet potatoes and others, are attacked annually by this organism.

During the past year experiments have been made to determine the effects of twelve different chemicals of various concentrations on the growth of this organism. The organism did not grow in sweet potato media containing ceresan, formaldehyde, and potassium metabisulfite in the proportions that were used. However, it grew abundantly in sweet potato media containing some of the other chemicals. Further studies are being made to determine the growth of the organism on several media, the hydrogen-ion and hydroxyl-ion range on these media, temperature range and comparison on these media, and other toxicity studies. (H. E. Eady.)

COTTON BREEDING AND IMPROVEMENT WORK

(In cooperation with the Division of Cotton and Other Fiber Crops and Diseases of the Federal Bureau of Plant Industry)

A study of cotton varieties and strains with special reference to new types suitable to the cotton production program of the state (No. 100).—Five variety tests of cotton were conducted during 1936, four in the Coastal Plain and one at Statesville. Standard varieties which have been grown in the state for several years and new varieties and strains were included. In the Coastal Plain region, Coker 100, Farm Relief (strains 3 and 4), Mexican 87-8 and Cleveland 884-4 were the highest yield varieties. At the Piedmont Station a stand was not secured until June 15 on account of the extreme drouth. Varieties producing the highest yields of lint were Coker 100, Mexican and Cleveland 884-8.

The regional cotton variety test was begun in 1935, and is being continued in 1937. This is a cooperative project between the Division of Cotton and Other Fiber Crops and Diseases and various state experiment stations. Fourteen of these tests are being conducted in the cotton growing states. The data which includes fiber and spinning tests has not been completed and results are not available.

A regional wilt test, similar to the above test, was begun in 1937. The objects are to study the susceptibility of varieties to Fusarium wilt, the probable existence of different strains of the organism, and the effect of applications of potash on the control of wilt, or the tolerance of varieties to wilt. (P. H. Kime and R. H. Tilley, cooperation Bureau of Plant Industry.)

Cotton breeding with special reference to meeting the needs of the manufacturers of the state (No. 104).—Line selection with the Mexican variety has been carried on at three branch stations for several years. At the Upper Coastal Plain Branch Station, at Rocky Mount, a large number of selections from Mexican Nos. 87-8 and 26-3 are being grown. Eleven strains were in the advanced test, and 48 other strains from the 1934 and 1935 plant-to-row were also tested. At the Central and Piedmont Stations 19 strains have been in the advanced test for two years. Slight differences in yield and some differences in length, uniformity and fineness of fiber were found. Some plant-to-row progenies were grown at the Upper Coastal Plain and the Piedmont Branch Stations, and quite a number of increase blocks were grown on the three farms. (P. H. Kime and R. H. Tilley, Cooperation Bureau of Plant Industry.)

A study of hybrid vigor in crosses between strains of the same variety (No. 112).—Crosses were made in 1929 between rather distantly related strains of the Mexican variety. Double crosses were also made in 1930. Selection in order to fix the type has been carried on during the past five years. Much of the material was discarded on account of short fiber length or other undesirable characters. A few selections from both the single and the double crosses were grown in 1936. Little, if any, improvement over the parents was evident. (P. H. Kime.)

Additional cooperative work is being carried on at Statesville and includes the following lines of work.—A "Skip Correction" experiment was begun in 1936, skips of 5 to 10 feet showed a fairly consistent correlation between the length of skip and the reduction in yield.

Inbreeding of commercial upland varieties for pure foundation seed stocks was begun last season. A number of crosses were made in 1936 between the leading varieties grown in the state. F_1 plants of these crosses were grown in the greenhouse during the winter of 1936-37 and double crosses were made.

A large number of perennial types and long season annuals were grown for observation in the greenhouse during the winter. A number of these planted from seed in September produced a crop of bolls during the winter. As much selfed seed as possible is being secured.

Most of the work at this Station has been in progress only a year or two, and for this reason no conclusions can be drawn at this time. (P. H. Kime and R. H. Tilley, cooperation Bureau of Plant Industry.)

Relation of fiber properties to spinning quality.—The main object of this project now being conducted in cooperation with the Federal Bureau of Plant Industry, which was begun in 1932, is to study the physical properties of fibers from improved cotton varieties and to note the relation of contrasting properties to spinning value. The results show significant differences in the staple length, fiber diameter, fiber weight, strength per fiber, per cent of thin-walled fibers, and yarn strength when the varieties are compared. The data also indicate that the influence of the growing seasons is an important factor which influences certain fiber properties and yarn strength. A preliminary report summarizing the results thus far secured is being prepared for early publication. (J. H. Moore, cooperation Bureau of Plant Industry.)

Relation of the distribution of the fiber population on the cotton seed to fiber length, strength, diameter, weight and wall development.—This work was started in 1935. Dated material from several improved varieties has been saved, and work is now being carried on to develop suitable methods of measuring the density of the fiber population at selected points on the seed coat and the relation of this degree of density to the various fiber properties mentioned above. (J. H. Moore.)

Origin and early stages of elongation in the cotton fiber.—The main object of this project, which was begun in 1934, is to study the origin of cotton fibers on the seed and to note any division of cells in the epidermal layer of the ovule subsequent to fertilization. Daily stages of the fruit ranging from flower buds to mature bolls have been preserved in several fixatives. Examination of the material has shown definitely that numerous cell divisions occur in the epidermal layers after the date of flowering. Work is now under way to determine whether any of these cell divisions in the epidermal layer lead to the formation of cotton fibers. (J. H. Moore.)

The influence of illumination upon the structure of the cotton fiber wall.—The main object of this work, initiated in 1935, is to determine the influence of constant artificial illumination upon the structure of the fiber wall. Results have been previously reported. A complete summary of the results is to be published in the October, 1937, issue of American Journal of Botany. These studies, which have been completed, have been conducted in cooperation with the Federal Bureau of Plant Industry. (J. H. Moore and D. B. Anderson.)

The relation of potash applications on quality and yield and to the control of "Rust" in cotton.—The main purpose of this work, which was started in 1934, is to investigate the relation of physical fiber properties, yield and "rust" in cotton to the application of potash salts in areas of the state where cotton and peanuts are grown in rotation. The results from two crops show that side applications of potash used to supplement 400 pounds of 3-8-3 fertilizer applied at planting time has increased the yield of seed cotton, boll and seed size, the lint index, strength of fiber, percentage of fibers having normal walls, staple length and grade; and also checked "rust" damage. During the year the complete results secured have been published in N. C. Exp. Sta. Bul. No. 308. (J. H. Moore and W. H. Rankin.)

COTTON FIBER INVESTIGATIONS LABORATORY**(Cooperation Bureau of Plant Industry, U.S.D.A.)**

1. **The origin and development of line and fuzz hairs.**—Two kinds of fibers: (1) the long lint hairs, and (2) the short fuzz hairs (linters) are present upon the seeds of most varieties of cotton. Considerable confusion exists in the literature relative to the origin and development of lint hairs and practically nothing is known about the early history of the fuzz hairs. This study was undertaken with three principal objectives in view: (1) to determine the period during which lint hairs develop upon the young ovules in different varieties of cotton; (2) to determine the relation between lint and fuzz as to the time and method of origin, and (3) to establish methods of differentiating between lint and fuzz hairs at an early stage in their growth.

The work was carried out upon seven varieties of cotton which were chosen because of the definite patterns of the lint and fuzz hairs upon the seed coats of the different varieties. Collections of the bolls were made at daily intervals during the first fifteen or twenty days after the date of flowering. The ovules were killed, imbedded in paraffin, cut into ten micron sections, stained and mounted in balsam in the usual way.

One of the varieties (King Naked) had no fuzz hairs so that all of the hairs formed from epidermal cells gave rise to lint. Two of the varieties (Cleveland Fuzzy Tip and Sea Island) had fuzz hairs restricted to the tip of the seed (micropylar end) with lint hairs present over most of the remaining surface of the seed. In these cases it was possible to identify the young lint and fuzz hairs by their position on the young ovules. The other varieties used (Mexican, Green Lint, Nankeen, and SxP) had both lint and fuzz hairs over the entire surface of the seed.

The results of this study indicate that the lint hairs of all the varieties studied arise as outward extensions of the epidermal cells, on the day of flowering or within three or four days of this date. The entire lint hair pattern is established during the first five or six days after flowering. The lint hairs first appear at the chalazal end of the seed, and others originate successively nearer the micropylar end. The fuzz hairs develop from the same layer or epidermal cells that gives rise to the lint hairs but they do not begin to appear until after the lint hair pattern has been fully established. The first fuzz hairs originate five or six days after the opening of the flower and they continue to form for a period of six or eight days. The results of this study have been prepared for publication. (A. G. Lang, D. B. Anderson and Thos. Kerr, cooperation Bureau of Plant Industry.)

2. **The elongation of cotton fibers.**—The cotton hair first appears as a small protuberance on the outer wall of an epidermal cell of the seed coat. This protuberance rapidly elongates until it attains a length of from one thousand to more than two thousand times its diameter. Little is known of the period of this elongation and almost nothing of the influence of environmental factors upon the period or rate of elongation. No correlations have been made between changes in boll size and the stages of fiber elongation. This project has three objectives: (1) To determine the period of time after flowering during which the lint hairs grow in

length; (2) To determine the rate of elongation and the influence of environmental factors upon this rate; and (3) To establish the relation between fiber elongation and the growth of the cotton boll.

The rate of elongation was determined by making collections of cotton bolls at daily intervals after flowering. The young ovules were dropped in boiling water to separate the lint hairs. The lint hairs were straightened and measured. The growth curves were plotted from averages of numerous measurements. Cotton varieties of different staple lengths were studied simultaneously so the growth curves of short staple and long staple cottons could be determined.

The elongation of the cotton hair was found to conform to the usual sigmoid growth curves characteristic of other structures. Elongation continues from the day of fiber origin for a period of from sixteen to twenty days after the opening of the flower. All cotton hairs regardless of the time of origin, cease elongating at about the same time. The boll also stops enlarging at the time that the hairs cease elongating so that curves of boll diameter level off at the same date that curves of fiber elongation flatten out. Some short staple cottons cease elongating earlier than long staple cottons, while others elongate more slowly for the same period of time as the long staple varieties. Staple length may be determined both by the rate of elongation and by the duration of the period of elongation. Environmental factors do not greatly influence staple length, but cold weather may decrease the rate of elongation so that the period of growth in length is increased. The results of this study will be prepared for publication in the near future. (D. B. Anderson and Thos. Kerr, cooperation Bureau of Plant Industry.)

3. The chemical composition of the lint hair wall during the period of elongation.—The wall of the cotton hair is known to contain cellulose and small amounts of pectic compounds. According to some investigators the cellulose does not appear until the wall is at least twenty days old. Others have reported finding cellulose in fibers that are six days old, and these latter consider that the wall of the fiber is largely, if not entirely, composed of pectic compounds previous to the appearance of the cellulose. This project was undertaken partly in an effort to throw some light upon these disagreements but principally to work out as completely as possible the chemical changes that take place in the wall during the growth of the fiber. A knowledge of these changes was considered an essential prerequisite for any satisfactory knowledge of fiber development.

Fibers were collected at twenty-four hour intervals after the opening of the flower. These fibers were subjected to the standard microchemical tests for cellulose, pectic compounds, cutin and waxes.

Cellulose and pectic compounds were found to be present in fibers within twenty-four hours of their origin. The delicate fiber-like strands of cellulose are embedded in pectic compounds. The cellulose could be detected only when the pectic compounds were removed by hydrolysis. The amount of cellulose in the wall increased slowly during the period of fiber elongation. No changes were detected in the quantity of pectic compounds. When elongation of the hair ceased cellulose deposition increased greatly in rate and quantity so that the wall of the fiber increased rapidly in thickness. The deposition of cellulose is continuous but not

uniform in rate so that zones rich in cellulose alternate with zones less rich in cellulose. It is this alternation of dense and less dense zones of cellulose that give rise to the so-called "growth rings" in the wall of the cotton fiber. No evidence was found to indicate that any pectic compounds are deposited in the cell wall after elongation ceases. No cutin exists in the outer surface of the fiber wall though definite evidence was found of the presence of small amounts of wax-like substances on the wall surface. The results of these studies are reported in a paper to appear soon in *Industrial and Engineering Chemistry*. (D. B. Anderson and Thos. Kerr, cooperation Bureau of Plant Industry.)

4. **The physical structure of the wall of cotton fibers.**—It is becoming more and more apparent that the properties of the cotton fiber are more closely related to the physical structure of the wall than to its chemical composition. In order to establish a solid foundation for studies of the properties of mature fibers an effort was made to work out the physical organization of the constituents of the fiber wall and to trace the changes in physical structure that occur during the development of the cotton fiber wall.

Fibers were collected at twenty-four hour intervals after the date of flowering. During the period of elongation the most successful results were obtained by staining the young fibers in strong Congo red and studying them between crossed Nicols. The structure of the secondary wall was determined by microscopical studies of fibers stained with strong chlorozinc iodide. These were supplemented by the results of the chemical studies previously described.

Under the ordinary microscope the very young fibers show no evidence, even after staining, of any type of wall structure. When the same fibers are observed between crossed Nicols they reveal the presence of a definite structural framework. This framework is composed of extremely fine thread-like strands of cellulose. In two-day old fibers these strands are oriented approximately at right angles to the long axis of the hair. In older fibers (ten-fifteen days) the cellulose strands are coarser and appear to be oriented in two flat spirals that run in opposite directions. The cellulose strands are roughly parallel to each other but anastomose freely forming an irregular network similar to that of a tennis net pulled strongly at diagonally opposite corners. The pectic compounds presumably fill the narrow meshes of this framework and surround the cellulose threads themselves. This structure is uniform over the entire wall, at the tip, at the base and at all intermediate points.

A new system of conspicuous spiral threads of cellulose which comprise the first position of the secondary wall, appears within a few hours of the time when elongation of the fiber ceases. These cellulose threads are easily seen with ordinary microscope when the fibers are stained with strong chlorozinc iodide. They bear no relation in size, angle or position to the delicate cellulose strands observed in the primary wall. The strands composing the secondary wall, like those of the primary wall, anastomose freely to form a coherent cellulose framework. The angle at which the spiral threads are deposited is neither constant in different parts of the same wall nor in the walls of different fibers. Commonly the threads run at an angle of about 45° to the long axis of the fiber but the angle of inclination may be considerably less than 45° .

Another important difference between the cellulose strands of the secondary and primary walls of the cotton fiber is the frequent occurrence of "reversals" in the former. A "reversal" is a place where the angle of the spiral threads is reversed so that a left hand spiral becomes a right hand spiral, or vice versa. Reversals are of two kinds: (1) The commoner type is formed by a bending of the cellulose strands in the form of an arc so that the direction of the spiral is reversed, and (2) frequently reversals are caused by one set of strands ending abruptly and another set beginning at approximately right angles to the first set. The ends of the two sets of cellulose threads overlap at the point of the reversal.

The spiral threads of cellulose that make up the first deposits of the secondary wall appear suddenly and over the entire inner surface of the primary wall at practically the same time. They do not start to form at the base or at the top and migrate from these positions. There is evidence, however, that the first deposit of the secondary wall may be initiated at numerous points on the inner surface of the primary wall and spread very rapidly from these centers of deposition.

Twenty-four hours after this first deposit of spiral anastomosing threads of the secondary wall appears another set is deposited on the inner surface of the first set. This second set of cellulose strands is similar to those first deposited except for the fact that the spirals may run in opposite directions. The reversals in the second set of threads may or may not coincide with those of the first set. New layers of spirally wound thread-like strands of cellulose continue to be deposited at approximately twenty-four hour intervals until the secondary wall of the fiber is completely formed. These subsequent deposits apparently conform in their general pattern to one of the patterns deposited during the first few days of secondary wall development.

The results of this study of the physical structure of the wall of the cotton fiber have been prepared for publication and will appear in the *Journal of Industrial and Engineering Chemistry* early in 1938. (D. B. Anderson and Thos. Kerr, cooperation Bureau of Plant Industry.)

5. Growth ring studies. It has been known for many years that the wall of mature cotton fibers gave evidence of a lamellate structure. Since the number of these lamellae could be correlated with the number of days during which the wall increased in thickness they have been known as "growth rings". The cause of these growth rings was unknown and their influence upon the physical properties was likewise unknown. An attempt has been made to determine the factors influencing the formation of these growth rings and to produce fibers free from growth rings. It was proposed further to make a comparative study of the structure and physical properties of cotton fibers without growth rings in comparison with fibers possessing growth rings.

Cotton plants were grown in field soil in large pots under continuous artificial light at approximately constant temperatures. Plants were successfully grown from seed to maturity and the fiber produced by these plants was sectioned and treated in such a way as to bring out any growth ring structure. Control plants were grown in pots under field conditions.

Cotton fibers produced under continuous artificial light possessed no

growth rings, while the control fibers developed under field conditions showed typical growth ring patterns. Collenchymatous cell walls of cotton plants grown under continuous artificial illumination showed the same type of lamellation characteristic of field grown plants indicating that the growth ring structure of the fiber wall is controlled by factors which have no influence upon the lamellation of other cell wall types in the same plant. The walls of fibers produced under the lights were indistinguishable in unswollen cross sections or in surface view from field grown fibers. They possess the same structural framework of long spirally wound threads of cellulose that is present in field grown fiber. Reversals seemed about as frequent as in fiber from plants grown under field conditions. The tensile strength of constant light fiber as measured by the Chandler bundle method was found to be equal or even slightly higher than that of field grown cotton.

In an attempt to determine the relative importance of light and temperature in controlling the growth ring pattern cotton plants were grown in the greenhouse where they were subjected to alternation of night and day but under conditions where temperatures were kept about 32° C. at all times. Fibers produced under these conditions failed to develop growth rings. They showed some evidence of a concentric structure but no true growth rings were formed. Other experiments indicated that variations in soil water content had no effect upon the growth ring pattern in the wall of the cotton fiber.

The results of some of these studies have been prepared for publication and will appear in the American Journal of Botany for October, 1938. (D. B. Anderson and Thos. Kerr, cooperation Bureau of Plant Industry.)

6. Boll temperature studies.—Preliminary studies of the temperatures inside cotton bolls of different ages have been made by means of thermocouples. The results are incomplete but indicate that bolls exposed to full sunlight are from two to eight degrees Centigrade warmer than the surrounding air. Temperatures in the interior of the bolls frequently were higher than surface temperatures. Bolls in the shade had temperatures only slightly above those of the surrounding air. During the night the temperature of the cotton bolls was found to be approximately the same as that of the surrounding air. (D. B. Anderson and Thos. Kerr, cooperation Bureau of Plant Industry.)

Seedling diseases and seed treatment.—In seed treatment studies with cotton treatment with New Improved Ceresan at rates varying from 4/5, 1-1/5, 1-3/5 and 2-2/5 oz. of dust per bushel of seed and with Ceresan at 2, 3, and 4 oz. per bushel of seed gave statistically significant increases in number of hills per row, number of seedlings per row, and average number of plants per hill for all rates of application when planted in Norfolk sandy loam at the Upper Coastal Plain Branch Station. The percentage increase in number of seedlings emerged ranged from 46 per cent to 157 %. In general New Improved Ceresan was somewhat more effective in improvement of stands than Ceresan when the comparisons are made on the basis of equivalent units of active ingredients in the dust mixture applied.

Results similar to the above were obtained when the same seed was planted on April 21 in Cecil sandy loam at Raleigh except that the in-

creases produced by the lower rates of application were not great enough to be statistically significant under the conditions of the test.

In plantings made May 5 in Norfolk sandy loam the same treatments as reported above gave increases in number of seedlings emerged ranging from 16 to 20 per cent. Statistical treatment shows the increases to be significant. Increases ranging from 3 to 10 per cent occurred in a planting made on Cecil loam soil May 3. Of these only the larger may be considered greater than could be expected from random variation.

Zinc oxide, copper oxychloride, and cuprous oxide (Cuprocide) applied to cotton seed at rates of 1 oz. and 3 oz. per bushel produced increases in percentages of seedlings emerged ranging from 20 per cent to 206 per cent in plantings made April 20 and 21 on Norfolk sandy loam and Cecil sandy loam soils. In plantings made May 3 and 5 at the above mentioned locations small but insignificant increases were obtained.

In the planting made April 21 acid delinted seed produced as good, but not significantly better stand than undelinted seed. In the planting on May 5 acid delinted seed gave a significantly greater emergence than undelinted seed. In the early planting significant and approximately equal percentage increases were produced by Ceresan treatment of delinted and undelinted seed, but in the late planting when conditions were more favorable for emergence of cotton seedlings, the Ceresan treatment benefitted the undelinted seed much more than the delinted seed.

Both the New Improved Ceresan and the Ceresan treatments decreased the percentage of plants dying after emergence and the percentage of plants showing sore shin lesions at the base of the stem. Both materials decreased the percentage of seedlings showing diseases cotyledons, these decreases ranging from 54 to above 90 per cent. A large part of this decrease was due to suppression of cotyledonary infection by *Bacterium malvacearum*, the organism causing angular leaf spot. Differences in angular leaf spot infection on treated and untreated rows was made evident as late as flowering time by greater shedding of leaves from untreated rows and by actual count of infected leaves.

During the spring and summer 35 lots of cotton seed picked up at random from farms in 19 counties in the cotton growing area of the state were tested to determine the percentage of infection with disease producing organisms. In only 4 of the 35 lots were less than 40 per cent of the seeds infected; all other lots had anthracnose spores on 40 per cent or more of the seeds. The average percent of seedlings which showed the anthracnose disease upon germination was 65.9. The standard error of this mean is 4.21. This indicates that the mean of the sample taken—65.9 per cent—is a close estimate of the actual average percent of anthracnose infestation in the cotton seed produced in the state. This astonishingly high degree of infestation of our cotton seed is a strong argument in favor of seed treatment before planting. (S. G. Lehman.)

Potash deficiency experiment with cotton.—From two years' results in these experiments very conclusive data has been secured. The cotton "rust" phase of the project was discontinued after it was found that "rust" reduced the yield, size of bolls, the length of staple, and percentage of mature fibers. It was found on the other hand, that the yields and other desirable qualities of the cotton were greatly improved by the use

of side-applications of potash, made immediately after chopping, where the cotton received 400 pounds of a 3-8-3 fertilizer mixture at planting time. It is suggested from the results secured in the peanut belt of the state that where not more than 3 per cent of potash is used in the fertilizer mixture at planting time that, after chopping, a supplemental application of potash be made at the acreage rate of 125 to 250 pounds of 20 per cent kainit, or 50 to 100 pounds of 50 per cent muriate of potash. (W. H. Rankin and J. H. Moore.)

Influence of acid and neutral fertilizers of different composition on quality and yield of cotton, Irish potatoes and sweet potatoes, and on soil fertility conservation of different soil types (No. 6).—The results on cotton for 1936 are included in a paper entitled, "Adapting high analysis and concentrated fertilizers to cotton soils."

The results on sweet potatoes and Irish potatoes are being prepared for publication to appear as an Experiment Station bulletin. The results as a whole indicate that properly formulated double strength fertilizers may be as efficient as single strength fertilizers for the truck soils of the state. (E. R. Collins and J. J. Skinner, cooperation Bureau of Plant Industry.)

A study of fertilizer placement factors influencing the stand, growth and quality of cotton (No. 5).—This experiment was inaugurated in 1936 to compare acid and neutral inorganic fertilizers with fertilizers containing 25 per cent organic nitrogen with different methods of placement. The comparison was also made between these fertilizers applied all at planting time versus half of the nitrogen sidedressed at chopping time.

The results for 1936 show that the cheaper inorganic fertilizers, when neutralized, gave results that compare favorably with the fertilizer containing 25 per cent organic nitrogen. When the fertilizer was placed 2.5 inches to each side, 3 inches below the seed, the fertilizer all-at-planting gave as good results as where half of the nitrogen was side-dressed at chopping time. Where the fertilizer was placed three inches under the seed there was considerable seedling injury and lower yields were obtained where all the fertilizer was applied at planting than where half of the nitrogen was side-dressed. (E. R. Collins, J. J. Skinner and R. W. Cummings, cooperation Bureau of Plant Industry and Bureau of Agricultural Engineering.)

Further studies on stains of cotton.—During the year further studies have been conducted on the stains of cotton caused by fungi. These studies have been carried out with special reference to the relationship between the fungi that occur on the leaves, bolls, and burs of the plant before the bolls open and the staining of the fiber. Attention has also been given to the temperature requirements of these fungi and to the time lint infection takes place.

The results of these studies show that the fungi on various parts of the plant prior to the opening of the bolls may also cause blue staining of the fiber. Rather high temperatures prevailed through North Carolina the last two weeks in August and the first two weeks of September (1937) which were very conducive to the development of the blue staining fungi. The greatest amount of infection occurs at the time the bolls are just beginning to open while the lint is still very moist. (O. P. Owens.)

Grade and staple of North Carolina cotton.—This study, which is a cooperative one between the Bureau of Agricultural Economics, U. S. Department of Agriculture, and the North Carolina Agricultural Experiment Station, is designed to obtain data on the quality of cotton produced annually in this state. Monthly and weekly reports are published throughout the ginning season giving the grade and staple of the current crop, and an annual report is issued after the end of the ginning season. Ginners who are cooperating in this project are given the classification of each sample received from their gins, and the classification is mailed direct to growers also in those instances in which the ginner furnishes their names and addresses on the card sent in with individual samples. In this manner the patrons of cooperating gins received the classification for approximately half of the samples classified during the 1936-37 season.

This study has revealed the interesting fact that North Carolina has made remarkable progress in the improvement of the length of staple produced since 1928. The average staple length for North Carolina and the United States for the period 1928 to 1936 is shown in Table 1. The average staple length of cotton produced in North Carolina increased from 14.69 sixteenths of an inch in 1928 to 16.07 sixteenth inches in 1936, while the United States average increased only from 15.18 sixteenths of an inch to 15.77 sixteenths of an inch, showing that the staple length of North Carolina cotton increased approximately $3/32$ of an inch, while the average for the United States increased only slightly more than $1/32$ of an inch. The major part of the change in production has been from less than $15/16$ inch staple to $15/16$ inch to $1-1/16$ inches staple. Ap-

TABLE 1. AVERAGE STAPLE LENGTH OF COTTON GINNED IN NORTH CAROLINA AND THE UNITED STATES BY YEARS, 1928-1936

Year	Average Staple Length	
	North Carolina (Sixteenth inches)	United States (Sixteenth inches)
1928.....	14.69	15.18
1929.....	14.75	15.11
1930.....	15.08	15.22
1931.....	15.29	15.44
1932.....	15.58	15.45
1933.....	15.31	15.55
1934.....	15.76	15.58
1935.....	15.65	15.47
1936.....	16.07	15.77

proximately 80 per cent of the cotton produced in 1928 was shorter than $15/16$ inch staple, while only 19.4 per cent was $15/16$ to $1-1/16$ inch staple. In 1936 only 13.3 per cent of the crop was less than $15/16$ inch, while 85 per cent of the crop fell in the group $15/16$ to $1-1/16$ inches. These and other results obtained under this project will be published during 1938. (Cooperation Bureau of Agricultural Economics, Glenn R. Smith and Ralph Raper.)

RESULTS OF BREEDING WORK WITH SMALL GRAINS AND CORN

Winter-Barley Seed Improvement.—The object of this research is to develop productive, smooth-awn types of winter-barley with resistance to loose and covered smut.

Yield trials were continued and smut inoculation tests run on a number of selections which have been carried since 1930. Bearded selections I-68 and II-15 are the most promising from the yield standpoint. Increase blocks of one acre each were grown. These will be further increased for distribution in 1938.

Preliminary tests indicate that certain strains are highly resistant to the different physiological forms of both loose and covered smut. Strain II-15, the highest yielding barley, showed only slight susceptibility to three out of twelve forms used. These tests will be repeated during the winter of 1937-38.

The development of satisfactory strains of winter barley carrying resistance to smut, and especially brown loose smut (*Ustilago nuda*), is the primary objective of work under this project. In the spring of 1936 crosses were made between Selection II-15 and certain smooth-awn selections. The first generation from this cross was grown during 1936-1937, and a good supply of seed is available for continuing this work. During the current year new crosses were made between several of the better strains and certain smut-resistant forms, including Pannier, *Hordeum deficiam* and *H. intermedium*. It is hoped that from these crosses satisfactory types carrying factors for smut-resistance can be isolated. (G. K. Middleton and W. H. Chapman.)

Winter-Oat Improvement in North Carolina.—The objective of this work is the development of winter-hardy strains with resistance to smut and crown rust; also to develop by hybridization and subsequent selection non-fatuid-producing strains of the Fulghum types of oats by using certain newly introduced non-fatuid-producing varieties.

Lee oats continue to be the most productive variety in the yield trials at the Piedmont Branch Experiment Station farm. Strain 5, a selection from Lee, has outyielded the parent variety over a five-year period by approximately 8 per cent. Two hundred bushels of this strain are available for distribution during the fall of 1937.

Crosses were made in the greenhouse at Raleigh between non-fatuid-producing strains of Russian oats and certain American-grown varieties. This material will be used for genetic studies and, if possible, for the development of adapted sorts which will not produce fatuid, or false wild types.

Winter-hardy varieties, carrying resistance to smut and crown rust are desirable for the Piedmont area of the state. Fifty-six selections from a cross of Lee and Victoria were received from the Office of Cereal Crops and Diseases of the U. S. Department of Agriculture during the fall and planted at Statesville in preliminary trials. These selections have shown high resistance to both smut and rust, and in cold-chamber tests have proven as cold resistant as in the Lee oat. Several of those look very promising, as they yielded as well or better than did the Lee oat this year. (G. K. Middleton and W. H. Chapman.)

Breeding Wheat for Disease Resistance and Winter-Hardiness.—The purpose in this work is to develop by breeding and selection varieties of soft red winter wheats adapted to North Carolina conditions which shall be an improvement over those now grown of the qualities of winter-hardiness and disease resistance, especially resistance to leaf rust.

Advanced yield trials were continued at the Piedmont Branch Station on thirty selections of wheat, thirteen of which are from local varieties and seventeen from hybrids carrying rust resistance. Two of the local selections (Fulcaster 151 and Leaps 157) were multiplied for distribution this fall. Preliminary yield trials were also run on sixty new rust-resistant selections at the Central Experiment Station farm.

Dr. Middleton also cooperated with the Federal Office of Cereal Crops and Diseases this year in two projects: (1) the growing of five standard varieties of soft winter wheat to be used for milling and baking tests in the federal laboratory at Wooster, Ohio; and (2) by conducting a unit of the Uniform Winter-Hardiness Nursery at the Mountain Branch Station farm.

While there was no winter-killing in the nursery at the Mountain Branch Station, due to the extremely mild winter, still valuable information was obtained on the adaptation of the thirty standard varieties used in the test. In general those from Ohio and Indiana seem to be better adapted to mountain conditions than our local varieties. This test is to be continued next winter.

Yield trials on the group selections at the Piedmont Branch Station should be practically completed after one more year, when more space and time will be available for other material. (G. K. Middleton and W. H. Chapman.)

Improvement of Corn Varieties.—In this work the purposes are

- (1) To develop varieties of corn for the Coastal Plain, Piedmont and Mountain areas of the state which will show improvement over those now used in yielding ability, quality of grain and in strength of stalk.

- (2) To study the value of top-crosses made at the time of the first selfing as an aid to the early elimination of undesirable strains.

- (3) To study the mode of inheritance of any plant characters which may be observed during the course of the work which have not been studied by other investigators, and especially characters whose appearance may be affected by environment.

Careful notes were taken in the fall of 1936 on maturity, strength of stalk and ear characters of fifty-six varieties of corn grown for observation and for starting the inbreeding program. This number was reduced to fourteen for planting in the spring of 1937. From these fourteen varieties five hundred and twenty-six first generation self-lines were planted this spring for further selfing and for making top-crosses.

Eighty-three top crosses from four varieties were also placed in the test this year. The results of these top-crosses, together with notes on the inbred parent lines, will be used in selecting lines for preliminary single-crosses in 1938.

Work was continued on the yellow-white crosses previously made by P. H. Kime, of this Department, with a view to developing a pure yellow

variety similar to the white parent variety. Plant hybrids are being made rather than selfing.

The procedure of selfing one ear on a stalk and top-crossing the second ear is being followed. Extreme hot and dry weather in the summer of 1937 prevented the development of but one ear to the stalk in many cases, this condition thus interfering to some extent with the program. In the future it will be necessary to use more fertile soil, with greater water-holding capacity, if the present plan of procedure is to be followed. (G. K. Middleton and W. H. Chapman.)

Protection of Stored Corn from Rice Weevil.—Further experiments indicate that the protection given to stored corn by clay dusts is probably mechanical. Two large glass tubes held in a vertical position were partly filled with shelled corn suspended on a coarse screen, the corn occupying about 17 inches of the tube. The corn in one tube was untreated, while in the other tube it had previously been mixed with kaolin, 1 part to 200 parts of corn. One hundred weevils were placed in the top of each tube in April. Within 12 days 100 weevils had fallen through the screen in the tube with dusted corn, and 4 additional ones came through later, the last on July 14. In 12 days only 39 weevils had dropped from the untreated corn, which became infested and continued to drop weevils which totaled 964 by October 12.

When corn was placed over kaolin in a jar without mixing, no protection was given. When kaolin was placed over corn without mixing, considerable protection was given, probably due to the kaolin sifting downward by the movements of the weevils. (B. B. Fulton.)

FRUIT AND NUT INVESTIGATIONS

Sandhills

Peach Fertilizer Studies.—There was a severe damage to trees on experimental plots during the winter of 1936-37. The immediate cause of the injury was cold, but contributing factors had probably rendered the trees susceptible. Areas of trees affected showed no relation to plots but were irregular in shape and extended through practically all treatments. Growth measurements have not been completely tabulated, but there are indications that the trees most seriously affected had made less annual growth each year than uninjured trees, suggesting an underlying soil or root condition as a contributory factor.

A series of late freezes during the spring of 1937 killed most of the fruit buds. Not more than five or ten per cent of a crop was set, making it inadvisable to take yield records.

A series of plots with peach trees of different ages has been started to study the relation of boron to longevity of the tree under Sandhills conditions. This work has not continued for a sufficient length of time to justify any conclusions. (C. F. Williams.)

Fruit Quality Studies.—Hiley and Elberta trees were thinned to comparable fruit loads at different periods during the fruit growing season and observations were made on the effect of such treatment upon fruit size and quality and on tree growth.

In all cases thinning favored production of a greater percentage of larger sized fruit but caused an appreciable reduction in total fruit yield and a reduction in net crop returns. With the Elberta variety early thinning favored somewhat higher yields than late thinning. Such was not the case with Hiley variety for this season. Data collected on tree growth for the Hiley variety only indicated a 25 per cent greater terminal growth and a 50 per cent greater fruit bud formation on thinned than unthinned trees.

Analysis of data taken on fruit and pit dimension relationships are to date incomplete.

Paper presented: "Some Tree and Fruit Growth Responses of the Peach as Influenced by Soil Moisture Conditions." Southern Agricultural Workers Conference, Nashville, Tennessee, February 3-5, 1937. (Ivan D. Jones, Coop. BPI.)

Raleigh

Root Development Studies.—During the past year ten corrugated steel tanks, six feet deep and seven feet in diameter fitted with concrete floors, have been constructed. These tanks have been filled with soil typical of the orcharding section of the Sandhills and are in use.

The experiments under way are designed to study the influence of soil moisture conditions, as altered by different cultural practices, upon tree and root growth. Observations will also be made upon the rate of leaching of certain fertilizer constituents. (Ivan D. Jones and Otto Veerhoff.)

Piedmont Station

Peach Fertilization.—Object: To study the effect of fertilizer elements in combination with cover crops on growth and production of peach trees in clay soils.

The following general observations are made:

1. The greatest growth, as measured by increase in trunk circumferences, has occurred on trees receiving nitrogen alone without cover crop. However, there is very little difference between nitrogen plus cover and NPK alone.
2. Least growth has occurred on trees receiving a winter cover of vetch (fertilized) and summer cover of soybeans (unfertilized).
3. High nitrogen plots are making excessive wood and foliage growth and are more difficult to prune than trees receiving complete fertilizer.
4. The difference in growth between the complete check and nitrogen alone to trees was only 1.25 inches.
5. While no conclusions can be drawn indications point to the importance of phosphorous and potash. This viewpoint may be changed as the trees come into full bearing. (M. E. Gardner.)

The Effects of Copper Compounds on the Control of Bacteriosis of Peaches.—For the first time in five years the bacterial spot of peaches was generally prominent throughout the sandhill area. In six orchards located in different localities in Moore, Lee, Scotland and Richmond counties three applications of copper zeolite, ammonium copper silicate (coposil), copper oxide (cuprocide), and copper phosphate did not give

satisfactory control of *Bacterium pruni* on Elberta and Hale peaches when applied at the rates of four pounds in 100 gallons of water and as the grower sprays. However, a much greater reduction in infection was obtained in orchards that indicated a very favorable nutrient supply. In two orchards where four applications were given the reduction in infection was good. The results to date indicate that all four of these copper compounds can be used on the peach. The copper phosphate and cuprous oxide have caused slight injury, but not enough to eliminate them from further consideration. It is also apparent that timing the sprays so as to have foliage and fruit well covered with the spray at the time of inoculum dispersion is an important matter. Various types of stickers, including Gulac, casein and emulsified summer oils were used. The oils indicated some values. Two brands of sulfur were used along with the copper material, including fused bentonite and flotation sulfurs. They apparently added some durable quantities to the spray. (R. F. Poole.)

The Effects of Some Cultural Practices on the Control of Bacteriosis of Peaches.—For some time the bacterial disease has occurred more consistently on the lighter soil types in Richmond and Moore counties than on slightly heavier soils where the general growing conditions of the trees were more favorable. It is rarely seen in the Piedmont on the Cecil and other clay soils. Since annual crops, including corn, cotton and tobacco, are generally severely injured by each of potash and magnesium deficiencies on these soils, it seemed possible that deficiencies of these substances in the soil may have some relation to the seriousness of the disease. For five years potash materials, including kainit, muriate, sulfate and sulfate of potash magnesia were applied annually in amounts of .5, 1, 2, and 3 pounds of potassium oxide to the tree. The potash did not reduce infection, but the application of sulfate of potash magnesia did indicate some reduction from the first treatment. During this season, soil treatments with this material and with magnesium oxide resulted in less bacterial infection and much less defoliation than that observed on the untreated trees. The magnesium, calcium and potassium content of the foliage and fruit on treated and untreated trees are being studied for the purpose of determining the relative importance of the three chemicals at the time of infection. (R. F. Poole.)

Mountain, Piedmont and Central Stations

Fruit Variety Studies.—Object: Varietal adaptability, possible commercial value, grower study and breeding.

1. Red summer apple seedling, U.S.D.A. No. 1, shows promise under conditions in Western Carolina. The fruits are of medium size, ripen with Yellow Transparent, and are very desirable for cooking. Other promising selections and varieties include U.S.D.A. Nos. 15 and 57, Joyce, Pedro and Melba.

2. Very desirable chance apple seedlings have been discovered in McDowell and Alexander counties. These will be followed and propagated as soon as scion wood can be secured.

As previously reported, a number of grape varieties have been added to our recommended list. (M. E. Gardner.)

Mountain Station

Apple Pruning and Training.—Object: 1. To determine the effect of the amount of annual pruning on earliness of bearing and productiveness.

2. To contrast the open center and modified leader methods of training and the comparative value of low and high heads.

This project was established in 1919 and is being concluded as it is felt sufficient data are available for publication. It may be necessary to grade representative trees from the various pruning treatments another year.

As a result of the experiment growers in Western Carolina have adopted a modified system of pruning. According to the treatments given this medium treatment has been more productive of quality fruit than either the extremely light or the very heavy plots. (M. E. Gardner.)

Pecan Breeding.—Object: To develop improved varieties especially adapted to North Carolina.

A very promising seedling has been selected as being worthy of distribution and has been budded on nursery stock this year. (Robt. Schmidt.)

Tree Performance of Bearing Pecans.—Object: To obtain annual yield records of individual trees of various varieties of pecans for comparison and permanent records.

Twenty-one years' yield records have been taken on a number of trees of our more important varieties. These records will be continued. (Robt. Schmidt.)

SMALL FRUIT INVESTIGATIONS

Central, Piedmont, Mountain and Coastal Plain Station Raspberry and Dewberry Breeding.—The work divides itself into three phases: (1) The crossing and hybridization, (2) The growing and study of hundreds of seedlings, and (3) The testing of selections. One of the most important problems in raspberries is to secure adaptation to conditions in the South. Several foreign species are being used in hybridization to attain this objective, as well as disease resistance. In dewberries market qualities resistance are principal objectives. Most of the breeding is done at Raleigh. Seedlings are being grown both at the Coastal Plain Station and at Raleigh, and selections are being tested in the different regions of the state.

The North Carolina selections, the Dixie red raspberry and the Cameron dewberry, continue to show promise where they are being grown and tested. (C. F. Williams, Coop. BPI.)

Dewberry Fertilizer Studies.—Plots on which late summer fertilization is being tested in comparison with the regular practice gave increases in yield of 15 and 30 percent. Growth measurements were secured but have not as yet been calculated. However, in previous years little difference in cane growth was secured with the different treatments. This season larger fruit clusters, many of seven fruits, were found on plots receiving late applications suggesting that increases in yield may be in part due to increased fruitfulness of canes. (C. F. Williams.)

Raspberry Fertilization.—Object: To determine the best fertilizer combination for the production of red raspberries in the clay soils of the Piedmont.

Plants fruited for the third time in 1937, the period of harvest extending from June 8 to July 2. Berries were harvested every day, unless prevented by rain, and weighed. Cane measurements and leaf counts were continued.

The experiment is laid out to include ten-plot treatments once replicated. Nitrogen is varied from 0 to 8%, phosphorus from 0 to 16%, and potash from 0 to 8%. In addition one plot receives complete fertilizer plus 5 tons of manure, and another receives manure alone at the rate of 10 tons per acre. The rate of application for nitrogen and complete fertilizer ranged from 0 to 1200 pounds per acre.

The highest yielding plot was that receiving ten tons of manure. This treatment produced at the rate of 6021 pints per acre. The second highest yielding plot received a 4-10-4 mixture at the rate of 400 pounds per acre plus 5 tons of manure, the yield being 4414 pints per acre. The lowest yield was harvested from the complete check as was to be expected, and the next lowest was harvested from the treatment receiving nitrogen alone.

Cane and leaf measurements and counts are being continued. (M. E. Gardner.)

Strawberry Spacing.—Relation of spacing to growth and fruiting of the strawberry and its value for new varieties.

The spacing work at Willard from which yield records were obtained in 1937 included matted beds, spaced beds, double-row hill system, and single rows of the Blakemore variety. The 1937 plantings included single-row plantings, in which a comparison will be made between early and late rooted runner plants of Blakemore, Missionary, Fairfax, and selections No. 669 and No. 419.

As a basis for future spacing studies preliminary runner length measurements were made in 1936 on several varieties and selections at Willard, Atkinson, Mount Olive and Swannanoa. During the 1937 season runner length measurements have been started at Willard, Raleigh and Swannanoa. Preliminary data indicate that the different varieties and selections may fall into short, medium or long runner groups.

Previous data by Darrow have indicated a relationship between leaf and number at the end of the growing season and yield the following spring. In order to check this under North Carolina conditions leaf counts were made in November, 1936, at Raleigh and Willard. Records of number of flowers and fruits per plant were obtained during the 1937 harvest season.

Analysis of data taken on runner length, leaf-to-fruit ratios, and spacing tests are to date incomplete. (E. B. Morrow, Coop. BPI.)

Soil Factors—Strawberries.—Effect of soils, soil amendments, organic matter, and crop sequences on plant growth, viability, production and quality of strawberries. (E. B. Morrow, Coop. BPI.)

Production, Time of Maturity and Quality of Strawberries (No. 8).—Four-year rotations, including many cash and cover crops, were inaugurated for strawberries at three locations in the state in 1936.

Each four-year rotation includes two cropping seasons for strawberries and includes such crops as cowpeas, sudan grass, lespedeza, sweet potatoes, snap beans, velvet beans, soybeans and oats appearing in the rotations in different order and with different fertilizer practices. Some of the crops are removed from the land, while others are utilized for soil improvement.

One experiment was inaugurated to study the time of application of fertilizers to strawberries in relation to yield and quality of the berries.

Experiments were inaugurated at two locations in the state to study the relationship of soil acidity to plant viability, yield and quality of strawberries. (R. A. Lineberry, E. R. Collins and J. J. Skinner, Cooperation BPI.)

TRUCK CROP INVESTIGATIONS

Raleigh, Faison, Cooperating Growers

Irish Potato Breeding.—Object: 1. To develop an earlier white, shallow-eyed, disease resistant potato of high yielding ability and good market value for mountain growers.

2. To produce an earlier potato with the yielding ability of Irish Cobbler, but with better tuber characters for eastern or early growers.

3. To produce varieties resistant to virus diseases, late blight and certain insects.

Approximately 1000 seedlings and named varieties were studied last year in single, ten and twenty hill units, and yield tests. Seedling No. 130.5-24 (Green Mountain x Katahdin) continues to give highest yields of all seedlings and selections in Western Carolina. The seedling also gave high yields at Oakland, Maryland, last year. It has shown resistance to leaf hoppers and late blight under field conditions. It was not resistant to blight, however, when inoculated in the greenhouse. This variety will be named and introduced after further test. Approximately 6000 seedlings were grown in pots in the greenhouse.

Progress has been made in the selection of early material and a number of seedlings will be grown in the early potato section in two and ten hill units in 1937. Identical plantings will be made in Portsmouth, Muck, Norfolk coarse sand, Cecil clay and Talledega stony loam, to study the performance of the selections under varying soil and climatic conditions.

Exchange of breeding material has been continued with the Bureau of Plant Industry and cooperating stations.

This project has been revised and enlarged and changed from the Hatch fund to Bankhead-Jones. (M. E. Gardner, Robt. Schmidt, Coop. BPI.)

Tomato Breeding.—Object: To develop desirable strains and varieties that are resistant to bacterial wilt and other wilt organisms.

This project was begun in 1936 with emphasis on bacterial wilt control. The Louisiana Pink variety has shown considerable resistance to this disease in field tests. Therefore the Louisiana Pink variety has been crossed with the Marglobe variety in order to get a more desirable market type with the added resistance.

Many varieties and strains of tomatoes have been grown in infected

soils for the past two years and selections made for resistance. Up to date no consistency has been shown by these selections in regard to the resistance to bacterial wilt. (Robt. Schmidt.)

Lettuce Breeding.—Object: To develop strains and varieties of lettuce which are improvements over present varieties, better adapted to North Carolina soil and climatic conditions and resistant to disease.

This project was begun in the spring of 1936 at Wilmington. Ten hybrid lines were grown, some of which were still segregating. Sixty-eight selections were made in the field, the plants potted up and brought into the greenhouse to produce seed. These selections, along with six new lines, were planted again in 1937. One of the 1936 selections showed great promise this year and will be planted in greater quantity for the 1938 crop. Seventy-two sections were made in the spring of 1937 for next year's crop. A few selections were also made in the field at Raleigh. (Robt. Schmidt, Coop. BPI.)

Observation and Trial Garden.—Object: To test new varieties and strains of vegetables and to carry on cultural practices with vegetable crops.

Twenty-five varieties of tomatoes were on test during 1937 but no new varieties were outstanding.

Sixteen varieties of sweet corn were grown at Raleigh, and also a latitude test was begun with sweet corn varieties in cooperation with the Connecticut Agricultural Experiment Station.

In the cabbage fertilizer test at Willard, the high phosphate plot again gave the best yield at the first cutting. This should be of considerable importance to early cabbage growers.

The seed stock of N. C. Strain No. 1 Porto Rico sweet potato is being kept up to a high standard by careful hill selection each year.

Thirty pea crosses and selections obtained from the United States Regional Truck Station at Charleston, South Carolina, were grown at Mount Olive, North Carolina, for observation. The lines of the Laxton's Progress type were the most promising. (Robt. Schmidt.)

A Study of Plant Absorption of Chemicals on the Control of Wilt of Sweet Potatoes Caused by *Fusarium batatatis*.—Sweet potato plants were allowed to stand in solutions of the chemicals for 24 hours and then inoculated with the organism and transplanted in the field. The results are promising, indicating reduction in infection can be obtained in this manner of plant treatment. The plant readily tolerated magnesium sulfate 1-300, ferrous sulfate 1-300, ammonium copper silicate 1-300, sodium thiosulfate 1-300, hydroxymercuriphenol 1-300. Acetic acid 98 per cent 1-500, and copper sulfate 1-1000 caused severe injury. (R. F. Poole.)

Pickle Project.—The 1936 studies pertaining to acid formation during the curing process verify similar studies previously reported from this Station. Analyses of brines and cucumbers showing other chemical changes occurring during the curing process are either to be reported with other cooperators or are at present incomplete.

Formation of hollow cucumbers or bloaters was found to be closely associated with the salt concentration of the brine used during the first two

weeks of the cucumber curing process. In general the use of brines of high initial salt concentration favored the formation of a larger proportion of bloaters. Salt stock quality at the end of the storage season was generally good, although small differences were observed between lots prepared according to the different salting schedules followed. Such differences will require additional study.

Dills prepared according to five different curing schedules were commercially unusable at the end of three months. It was necessary to discontinue this phase of the project until another growing season.

Fertilizer studies designed to indicate the influence of the fertilizer program on the chemical and physical nature of the fresh and cured cucumbers are in progress. Mr. Robert Schmidt has assisted in the cultural phases of this portion of the project.

Microscopic studies of fresh cucumber and salt stock structure are being made with special reference to cellulose, pectic compounds and lignin. The cause of softening of stock and the accompanying cellular changes are being investigated.

Material has been prepared for analyses for the structural changes of cucumbers in relation to size, age of plant, and fertilizer practice. (Ivan D. Jones and Otto Veerhoff, Coop. BPI.)

Fertilization of Vegetable Crops on Mountain Soils.—Cooperative studies were continued with the Tennessee Valley Authority. Differential fertilizer applications were studied using snap beans, cabbage, sweet corn and Irish potatoes. The cooperation of the grower on whose farm the tests were conducted was much better than that of other growers in previous years, therefore, results are considered more reliable.

Data are not complete but a full report will be forwarded to the Tennessee Valley Authority as soon as analyses have been made. (M. E. Gardner and Robert Schmidt.)

Corn Earworm Control on Sweet Corn.—Materials were applied to corn silk by means of a solid stream jet coming through an opening 1/32 inch in diameter. Lead arsenate again proved superior to all other poisons applied. In three successive plantings the percentage of worm-free ears for the combined rows treated with lead arsenate as compared to check rows were as follows: lead arsenate 79%, check 25%; lead arsenate 67%, check 7%; lead arsenate 26%, check 0%. Synthetic cryolite gave the next best control with 59% worm-free ears compared to 7% in the check row.

In series using lead arsenate with several concentrations of wetting agent and without a wetting agent, there was little difference in the control, but where the poison was used alone there was greater injury to the silks, causing them to rot above the tip of the ear in many cases. Lead arsenate and corn meal (1 to 75) rubbed on the silks gave very little control and was inferior to lead arsenate dust. One row in which lead arsenate with a wetting agent was applied after clipping the fully formed silks, had the greatest percentage of worm-free ears (49%) in the third planting when all check row ears were infested.

In order to obtain evidence as to the extent of poison deposit on the grains of corn, lead arsenate was mixed with an equal quantity of lamp black and applied without a wetting agent and with "Ultrawet" 1 to 4000

and 1 to 1000. The black in all three treatments was found mostly on the silks and husks, but some of the ears showed a little black at the tip of the cob or on the grains near the tip. In the variety grown (Red-Green hybrid) there is usually about an inch of tip without grains. Where no wetting agent was used 23 % of the ears showed some blackened grains; with "Ultrawet" 1 to 4000 there were 6 %, and with the 1 to 1000 concentration 20 % showed blackened grains. In most cases grains showing a black deposit were visibly injured. (B. B. Fulton.)

Pickle and Melon Worms.—Plots of summer crook neck squash were dusted at weekly intervals, eight times beginning on July 2. Three materials were used: (1) Derris powder (manufacturers label, 5 % rotenone) 1 part, talc 5 parts; (2) lead arsenate; (3) synthetic cryolite. Squash of all sizes were picked at weekly intervals with results in percent infested as follows:

Treatment	July 6	July 23	July 29	Aug. 4	Aug. 11	Aug. 18	Aug. 27
Derris.....	2	3.3	19.8	14.	55.7	84.	86.
Lead arsenate....	0	4.	6.6	0.	17.	36.8	48.
Cryolite.....	0	7.	5.4	2.3	17.6	30.3	71.7
Check.....	0	7.7	29.	21.6	40.4	71.8	Plants dead

The results indicate that both lead arsenate and cryolite are much superior to rotenone dust for the control of the pickle worm. As in the previous year, no melon worms appeared on the plants until the end of the season. Check plants had been killed by worms feeding on the growing tips by August 27, and the rotenone dusted plants were nearly gone at that time, having only 7 squash compared to 104 and 46 on the lead arsenate and cryolite plots. A few plants in the lead arsenate plot were still living on October 1, although receiving no dust after August 20.

Cantaloups grown beside the squash did not become infested until early in August, and never to the extent that the squash were infested. As in the previous season, the pickle worms infestation dropped in September due largely to the dying of the vines. Moths emerged on October 4 from worms collected September 11. Since the moths emerge until fall and apparently do not hibernate, it seems improbable that the practice of burning old vines would have much value in reducing the infestation of the next summer. (B. B. Fulton.)

Harlequin Cabbage Bug.—It has been observed in field experiments that rotenone dusts gave good control of harlequin bug in summer, but poor results in spring and fall. In laboratory experiments where dusted bugs were confined on plants in two constant temperature chambers at 90° F. and 67° F. it was found that the mortality was much greater at the higher temperature. (B. B. Fulton.)

Cabbage Maggot.—At Glenville, Jackson county, North Carolina, cabbage maggot flies from over wintering puparia were numerous up until May 28, but had become scarce by June 16. On June 19 the first adults of the second generation were obtained. Cabbage plants that came up

by May 15, or later, were not seriously affected by the maggot. Turnip and radish seed coated with mercurous chloride showed poor germination and cabbage seed so treated was retarded. The few radishes that germinated from coated seed were much less infected. In another experiment performed too late for maggot infestation, turnip, radish and cabbage seed coated with mercuric oxide failed to germinate; cabbage and radish coated with mercuric sulphide germinated as at the same time as the check, but turnip seed so coated failed to germinate. (B. B. Fulton.)

INVESTIGATIONS IN FLORICULTURE

Raleigh, Castle Hayne

Cooperative Bulb Fertilizer Experiment.—During October, 1936, a fertilizer experiment with bulbs was started in cooperation with the United States Department of Agriculture and the bulb growers in the vicinity of Castle Hayne and Wilmington, North Carolina. The objects of this experiment are: (1) To determine the best fertilizer formulae for the soil types represented in the bulb-producing region of the state; (2) To study the effect of the minor elements, manganese, magnesium, copper and boron on growth and production; (3) To determine the best rates of application; (4) To determine the best time or times of application; (5) To determine the effects of different fertilizer treatments on the storage qualities of the bulbs; and (6) to observe the effect of different fertilizer treatments on disease infection of bulbs.

The results for this year will not be complete until more data can be taken on the bulbs from the experiment which are in storage at this time.

Plans have been made to enlarge and repeat the experiment for next year. (G. O. Randall, J. G. Weaver, S. L. Emsweller, D. Victor Lumsden, Coop. BPI.)

The Propagation of Floral Crops.—The experiment started during 1933-34 for the purpose of determining the best location on the plant from which to take cuttings was continued during the past year. As previously stated, cuttings were taken from each of the following locations:

- 3 nodes from the flower bud
- 4 nodes from the flower bud
- 5 nodes from the flower bud
- 6 nodes from the flower bud
- 7 nodes from the flower bud
- 8 nodes from the flower bud
- Immature flower shoots

Shoots from the base of the plant near the ground.

The results indicate conclusively that the position on the plant from which the cutting is taken makes little or no difference in the yield from the resulting plant. (G. O. Randall and J. G. Weaver.)

Tests of New and Standard Flowering Plants—Carnation Variety Test.—This test was continued again this year, and of the eighteen varieties tested the following five produced the highest yield: Vivian (pink), Satellite (red), Dimity (variegated white and purple), Chief Kokoma (variegated yellow and pink), and Peter Fisher (light pink). Also included in this test were two seedling carnations developed at this Station

designated as N. C. 38 and N. C. 30. N. C. 38 produced a higher total yield than any of the other varieties in the test, while N. C. 30 produced a greater total yield than any of the named varieties with the exception of Vivian. (G. O. Randall and J. G. Weaver.)

Rose Variety Test.—Only three varieties of roses—Mrs. Frank Schramm (pink), William Ekas (novelty), and Briarcliff (pink),—were included in the test this year. Mrs. Frank Schramm led in total yield, followed by William Ekas and Briarcliff. (G. O. Randall and J. G. Weaver.)

LEGUME AND GRASS INVESTIGATIONS

Soybean Studies (No. 240).—Hay yields from the eleven varieties ranged from 1645 to 3049 pounds per acre. The Otootan, Ludeke and Pee Dee were the leading hay varieties. All seed yields were low, but the Large Seeded Tokyo, Biloxi and Herman were the best seed producers.

Yield data have been obtained for one season from 19 of the most promising strains from a Mammoth Yellow x Biloxi cross. Several of these are non-shattering and are higher yielding than either the Mammoth Yellow or Biloxi varieties. They are not yet uniform in their non-shattering habits.

Of the more than 100 recently introduced strains at this Station the following have shown considerable promise for seed and forage purposes in preliminary tests:

80821	86971
84802	86992-1
85326	87001
85459	88536-3
86920	96972

Preliminary tests indicate the following to be the most promising for green vegetable purposes:

82321	85883
82591	85886
83947	95733
85560	96018

The oil content of a few introductions ran from 15 to 25 per cent higher than did the Mammoth Yellow variety. (R. L. Lovvorn, Coop. BPI.)

Studies of the Utilization of Crotalaria Species Under Coastal Plain Soils and Cropping Conditions (No. 241).—Yields of crotalaria seed continue to be greater on fertilized than unfertilized land, and to be greater when grown in a two-year rotation with corn than when grown in a three-year rotation with two years of corn and one-year of crotalaria.

The moisture holding capacity of the soil has been slightly increased by cropping with crotalaria.

No corn was produced on the continuous corn plants this year because of severe attack of bill bugs and southern root worms.

A two-year rotation of corn and crotalaria has almost doubled the yield of corn, whereas in a three-year rotation where corn is grown two years in succession before being planted to crotalaria, the second crop of corn has decreased quite materially in yield. Harvesting crotalaria seed has not significantly influenced the yield of corn in a corn-crotalaria rotation. (R. L. Lovvorn, Coop. BPI.)

Acid Tolerant Legume and Grass Nursery (No. 242).—Detailed observations have been made as to persistent qualities, growing habits, seeding habits and ability to withstand adverse weather conditions for both summer and winter annuals and perennials.

The crotalarias, subterranean clover, hairy vetch and Austrian winter peas and several strains of lespedeza sericea appear most promising as forage and soil-improvement crops for eastern North Carolina. (R. L. Lovvorn, Coop. BPI.)

Environmental Factors Affecting the Establishing of Permanent Pastures in the Coastal Plain Area of North Carolina (No. 243).—A portion of this project was begun in 1934 on muck soil at Wenona at which time a number of fertilizer treatments were made with permanent pasture seedings. The predominating species now is Kentucky blue grass. Barnyard manure at the time of making this report is the most effective of any soil treatments in increasing the vegetation.

A second section on muck soil at Wenona was planted to soybeans for three years before being seeded in 1937. The soil treatments were the same as used in 1934, but in the latter cases a number of permanent pasture species were seeded alone in order to study their habits and adaptation in the muck lands of this state.

A third portion of this project was started in the spring of 1937 on a typical well drained Norfolk fine sandy loam soil in Johnston county. This study will include the relative values of 22 seeding mixtures and eight fertilizer treatments in establishing a permanent sward. Methods of evaluating the sward by vegetative analysis will also be studied. No results have yet been obtained. (R. L. Lovvorn.)

A Study of Cowpeas Resistant to Wilt Caused by *Fusarium vasinfectum* tracheiphilum, Root Knot Caused by *Heterodera marioni*.—A species of Iron cowpea was obtained several years ago in Wilson county. It attracted attention because of its resistance to both the wilt and nematode diseases. The strain is not widely known, although growers have sought varieties that would resist the two diseases. It was subjected to heavy inoculations of causative organisms of both diseases during the year along with Crowder, Whippoorwill, Clay, Black, Brabham, Black Eye, and other varieties. The variety remained highly resistant under conditions that favored the development of the two diseases. The other varieties were all found to be susceptible, and in most cases became very severely diseased by both organisms. The strain of Iron was also more resistant to drought than other varieties tested. It is equally susceptible to the powdery mildew. The variety produces rank vine growth, but yields sparingly. Regardless of earliness of planting it matures seed late in September. It is a variety that plant breeders might cross with other varieties and improve the yielding qualities without lowering its resistance to the two important diseases. (P. H. Kime, O. P. Owens, and R. F. Poole.)

PEANUT INVESTIGATIONS

Effect of Breeding, Selection and Spacing Upon Yield of Quality of Peanuts (No. 102).—The total yields of different spacings were fairly close together, but tended to increase as the number of plants per unit

area increased. The percentage of large nuts was greater on the plats spaced one plant to the hill. Spacing apparently had little effect on grade and class of the nuts produced.

Yields of different strains ranged from 1297 to 1636 pounds per acre. There was considerable difference in the percentage of total handpicks, but the highest yields strain was also one of the highest in percentage of handpicks. All strains were attacked by Southern root rot.

Planting nuts two to three inches above the soil level produced larger yields than when they were planted two to three inches below the level where a weeder was used. Lack of uniform land prevented the drawing of definite conclusions regarding the effect of frequency of weeding on yield and quality. (R. L. Lovvorn.)

Study of Factors Influencing the Productivity of Peanut Soils (No. 172).

—Previous experiments have indicated that the beneficial effect of calcium sulfate applied on the foliage at blooming time of the plant vines is due to the calcium which it supplies in an available form. Studies of the effects of kinds and amounts of calcium on the yield and quality are being continued in concrete frames filled with a characteristic virgin peanut soil. Limestone continues to be very effective in increasing both the yield and quality of nuts. The response to calcium sulfate was greater this year than in 1935.

As a rule the percentage of calcium oxide in the plant is very closely correlated with yields. In almost every case the plants receiving calcium sulfate contained more calcium than plants receiving limestone only. There seems to be a relationship between the amount of calcium and potash in the plant, but little if any between calcium and nitrogen. (R. L. Lovvorn.)

Peanut Leafhopper.—This past season laboratory and field experiments have proven beyond a doubt that the disease which is known locally as "pouts" is caused by the common potato or bean leafhopper. This disease appears first as a distinct blackish discoloration at the tip of the leaflet, and the discoloration progresses gradually toward the base of the leaflet until the whole leaflet is involved. If the disease is severe the entire leaf turns blackish, shrivels and dies. Typically, in the field, the plants recover about blooming time and there is no further evidence of the disease. At this time also, the leafhoppers disappear from the peanut field and seem to migrate to the fields of soybeans. Although we have not as yet been able to prove this migration in the field, all the evidence points in that direction.

In the field plants which were protected from the leafhoppers, the disease did not develop, whereas unprotected plants did develop the disease. Plants in the field which had the disease and which were freed from leafhoppers and protected by cages recovered. Diseased plants moved from the fields to the laboratory freed from leafhoppers and kept free recovered rapidly and made normal growth. Plants which were not freed from leafhoppers continued to show the effects of the disease, and if the number of leafhoppers was large the plant was killed outright. In the laboratory we have shown that the disease known as "pouts" is caused by what may be termed the mass effect of toxins. In the laboratory small plants, with two leaves, which were in good growing condition

and which were stimulated by plant food and frequent waterings, were able to outgrow the effects of one or two leafhoppers per plant. Those, however, which had three or more leafhoppers per plant did not recover and were killed, thus showing the mass effect.

This insect is also a serious pest of alfalfa, clover, garden beans, cow-peas, soybeans, garden beets, Irish potatoes and cotton. It is our present plan to study the ecology of this species more in detail next year with special reference to more effective methods of control for these various crops. (Z. P. Metcalf.)

A Study of Soil Treatment for the Control of the *Sclerotium rolfsii* Disease of Peanuts.—The disease caused only slight losses of plants this season. Favorable seasons for excellent stands, which were maintained throughout the season, also delayed the conditions known as maturity and suitable for harvest. The harvest has been mostly premature, and fewer nuts were broken off and left in the soil than in 1936. It was apparent in 1936 that *Sclerotium rolfsii* was attacking the petioles as well as the nuts and caused separation of the nuts from the vines. On some counts it was apparent that more than fifty per cent of the nuts were broken from the plants and left in the soil because of no better method of harvest. Further studies show that the fungus attacks and rots the petioles, immature nuts extensively and to some extent, the mature nuts. Mature Sclerotia were found in the diseased nuts, especially in poorly drained areas, but to some extent throughout the field. It was apparent that heavy losses were overcome by better timing of harvest, although many plants were harvested before a majority of the nuts forming had matured. It is also apparent that the condition of the nuts at harvest is influenced by heavy defoliation, caused by *Cercospora personata*.

On an area where 75 per cent of the nuts broke off in the soil in 1936 sulfur and lime each broadcast at the rates of 1000 and 500 pounds to the acre on the same plot indicate improvement in growth and suppression of the disease. Zinc oxide and zinc sulfate at the rates of 500 and 100 pounds to the acre, respectively, suppressed growth without reducing losses caused by *Sclerotium rolfsii*. A mixture composed of eight inorganic elements rarely supplied in fertilizers were proportionately mixed and applied at rates of 1000 pounds to the acre broadcast, and 300 pounds to the acre in the drill has improved yields and reduced losses. (R. F. Poole.)

DAIRY INVESTIGATIONS

Whole Peanut Plant for Dairy Cattle.—The peanut plant is an important commercial crop in a section of this state. By-products have been used, such as hay for cattle feeding, and the hogging-off of nuts has been practiced in swine feeding.

In this study the whole peanut plant is ground and fed in the dairy ration with the idea of determining the possibility of marketing a part of the peanut crop as feed for dairy cattle during years of over-production.

The peanut plant used in the first trial was inferior, as shown by leafiness, color and dirt, due partly to weather conditions during the curing season.

The following rations were fed:

RATION I

Corn (ground) -----	400 #
Cottonseed meal -----	300 #
Bran -----	200 #
Oats -----	100 #
Corn silage	
Soybean hay	

RATION II

Whole peanut plant -----	1000 #
Cottonseed meal -----	500 #
Corn meal -----	500 #

During the first trial the peanut plant ration produced more milk than Ration I. The second feeding trial is in progress. (C. D. Grinnells and J. L. Moore.)

Dairy Cattle Pasture Studies II.—Central Station.—The results for the 1937 pasture season show the plat yields in total digestible nutrients in their same relative position, but the yields are not quite as large as for the 1936 season.

FERTILIZER APPLICATIONS PER ACRE

Plat No.	Pounds of Plant Food Per Acre		
	N	P205	K20
1.....	59.1	37.5	18.75
2.....	52.3	37.5	18.75
3.....	Check—No fertilizer		
4.....	-----	37.5	18.75
5.....	41.1	37.5	18.75
6.....	29.95	37.5	18.75
7.....	-----	75.0	-----
8.....	18.75	37.5	18.75

The following table gives the net total digestible nutrients per acre for each plat.

	Plat 1	Plat 2	Plat 3	Plat 4	Plat 5	Plat 6	Plat 7	Plat 8
1929-34 (av.).....	1858.8	2006.2	1258.0	1898.9	1916.9	1670.6	1027.9	1455.7
1935 (no fert.).....	1858.8	1680.0	1255.6	1524.8	1426.4	1530.4	1224.0	1598.4
1936.....	2395.0	2103.0	1913	2174.0	1939.0	1314	1529.0	1839
1937.....	1779.2	1819.6	1265.6	1720.0	1676.8	1448.4	1177.6	1484.4

The different plats are going into the winter with a better turf and more vegetation than ever before. (C. D. Grinnells and J. L. Moore.)

Dairy Cattle Pasture Studies III.—Mountain Branch Station.—The 1937 data give the results of the seventh year of this study of intensive fertilization. Plat 4 which has not been fertilized for two years, is con-

tinuing to improve. This plat was heavily infested with ground moles which have almost been eradicated by trapping.

The net yield expressed in total digestible nutrients per acre for 1937 is as follows:

	Plat 1	Plat 2	Plat 3	Plat 4	Plat 5
Total digestible nutrients per A. (1937).....	2629	2654	1844	1617	2159

The fertilizer applications per A. for the above plats are as follows:

Superphosphate.....	300	300	300	0	300
Nitrate of soda.....	160	260	0	0	360
Muriate of potash.....	50	100	50	0	50

All plats show an increase in yield over that of the previous year. (C. D. Grinnells and J. L. Moore.)

Dairy Cattle Pasture Studies III-A, Ashe County, R. W. Hardin Farm.—This study of three two-acre plats is grazed by a small herd of dairy cattle.

FERTILIZATION FORMULA

Plats 1 and 3

Per Acre

Nitrate of soda 16 %	100 #
Superphosphate 16 %	200 #
Muriate of potash 48 %	33 #

In addition Plat 3 receives 100 pounds per acre of top dressing on May 1st each year. Plat 2 is a check plat.

The results do not show a significant advantage from top dressing. The fertilized plats gave approximately twice as much grazing as the check plat.

G. B. Price Farm.

FERTILIZER FORMULA

	Plat 1	Plat 2	Plat 3	Plat 4	Plat 5	Plat 6
Phosphoric acid 16%.....	600	600	0	600	0	600
Muriate of potash.....	-----	100	0	100	0	-----
Sodium nitrate.....	-----	-----	-----	300	-----	-----
Lime.....	3000	3000	0	3000	3000	-----

YIELD IN TOTAL DIGESTIBLE NUTRIENTS

Yield in T. D. N.	4777.4	5194.2	4657.9	3510.9	4076.0	3488.5
Cow days.....	-----	-----	-----	-----	-----	-----
Grazing per plat.....	25	30	24	23	20	18

This pasture is located on a steep hillside and the turf lacks the denseness desired in good pastures. This is being corrected by a seeding of Kentucky bluegrass which was made two years ago, was followed by a very dry season but has caught and is spreading rapidly. This is especially true on the plats receiving phosphoric acid and lime. The turf at the top of the hill is excellent in that the bluegrass is dense and the white dutch clover is very prevalent.

This project shows clearly the need for lime and phosphoric acid in building pastures in this section.

Phosphoric acid alone as in Plat 6 does not produce nearly the same results as when coupled with lime as in Plat 1, or lime, phosphorus, and potash as in Plat 2. (C. D. Grinnells.)

Kudzu as a Supplementary Pasture, Central Station.—The kudzu made an unusual growth this season. It is from three weeks to one month later than permanent pastures for spring grazing and cannot be relied on as an early grazing crop in this section. It is also killed by the early frost.

Fertilization with 300 pounds per acre of phosphoric acid (TVA) with well distributed precipitation produced a growth approximately twenty-five per cent greater than attained previously.

Lespedeza Sericea as a Supplementary Pasture Crop, Central Station.—Three acres of lespedeza sericea were planted in 1933 and a partial stand was obtained. The areas that failed to develop a stand were replanted in 1934 and 1935, but reseeding failed in spots. This year's crop was allowed to mature, after which it was cut and spread on the bare areas in an attempt to obtain a uniform stand.

Lespedeza sericea on this plat does not appear to be the competitor of weeds, and other species that it is reported to be at other stations.

Fertilization with 300 pounds per acre of phosphoric acid (TVA) produced a twenty per cent increase in yield of vegetation but did not appear to correct the difficulty responsible for a lack of stand on the bare areas. (C. D. Grinnells, J. L. Moore.)

Ashe County Roughage Studies.—In this study relative yields, protein content, digestibility and feeding value are being studied. The yield from the two areas was much greater this year and seasonal conditions made it possible to cut at an earlier date. The first cutting was made 23 days earlier than last year, with the second cutting 15 days earlier.

Chemical analysis to determine the variations in the content of last year's cuttings show some interesting trends in the protein content. (C. D. Grinnells.)

Cooperative Dairy Crop Utilization, Central Station.—The corn, cotton, legume rotation appears to be showing the effects of the manure from the dairy herd and from the legumes plowed under. There is small increase in yield in all the crops. Part of this may, however, be due to the favorable season.

The cost of milk production shows a small increase this year due to the increased cost of purchased feeds. (C. D. Grinnells and J. L. Moore.)

The Economy of Feeding Beet Pulp, Mountain Station.—This study is to determine the advisability of buying beet pulp for a commercial dairy herd when an ample supply of good corn silage is available.

The first feeding trial has been completed and no advantage was obtained by the addition of beet pulp. When on the beet pulp ration there was a slight decrease in silage consumption, but the unit cost of product in milk or butterfat was high. (C. D. Grinnells, S. C. Clapp and H. B. Coulter.)

Digestion Trials, Central Station.—Digestion trials have been run on lespedeza sericea, peanut hay, peanut plant (whole), and on early and late cut meadow hay consisting largely of timothy and clover.

Samples are being analyzed and some of the trials will be repeated this winter. (C. D. Grinnells and J. L. Moore.)

ANIMAL HUSBANDRY INVESTIGATIONS

Retarded Growth Studies with Swine—VII.—The study of the relation of growth in pigs, when controlled by level of feeding, to the production and quality and palatability of their meat, was continued with 30 pigs in the same manner as last year, namely:

Group VII a—Full fed from weaning to slaughter in dry lot

Group VII b—Limited on pasture to 100 pounds, then full fed in dry lot to 225 pounds

Group VII c—Limited on pasture from weaning to 225 pounds.

The Group VII a—pigs that were full fed from weaning to slaughter required only 114 days to reach an average weight of 225 pounds, as compared to 353 days required by the Group VII c pigs which were fed a limited ration on pasture to the same average weight.

The amount of feed required per unit of gain was reduced by limiting the ration and adding pasture, since Groups VII a, b and c required, respectively, 354, 339 and 286 pounds of feed, exclusive of pasture, for each 100 pounds of gain produced.

The fat of the carcasses from Group VII c was distinctly less firm than that from Groups VII a and b. (Earl H. Hostetler and J. E. Foster, cooperation BAI.)

Effect of Feeding Varying Amounts of Soybeans to Pigs—IV.—Three pigs were fed individually, and ten pigs were group fed on three rations containing 30, 40 and 50 per cent ground soybeans. The pigs were started on feed at approximately 60 pounds each, and were continued on the soybean rations until they had made an average gain of about 40 pounds, after which they were changed to a corn-cottonseed meal ration until ready for slaughter at approximate average weights of 225 pounds. Three additional pigs were fed individually, the corn-cottonseed meal ration throughout the entire period.

The amount of soybeans in the ration seemed to have little influence on the amount of feed required per unit of gain, on the rate of gain, on the dressing per cent or on the firmness of the carcasses. The carcasses from each of the 42 pigs were graded hard and the grading was corroborated by the Refractive Index readings. (Earl H. Hostetler and J. O. Halverson, Coop. BAI.)

Fish Meal vs. Peanut Oil Meal for Fattening Pigs.—Forty 94 pound pigs were used in one feeding trial to compare fish meal and peanut oil meal as supplements to shelled corn and mineral for fattening pigs.

All of the pigs were self fed free choice in dry lots with Group 1 receiving fish meal as its protein supplement, and Group 2 receiving peanut oil meal.

Both groups were full fed for 68 days, but during that time the pigs on fish meal made an average gain of 96 pounds, as compared to 78 pounds for the Group 2 pigs. The latter group also required 15 pounds more feed per cwt. gain than the fish meal group. (Earl H. Hostetler, Coop. Blackland Station, Wenona, N. C.)

A Study of Pastures and Their Utilization by Sheep.—This study for the fiscal year 1936-37 comparing the three four-acre fields was conducted as in the two preceding years, with the following two exceptions: Korean lespedeza was sown with both the rye and rye grass, no Kobe lespedeza being sown. Fields 2 and 3 were divided equally in the fall of 1936 and one-half of each sown to rye and the other half to rye grass.

The grazing from these fields from July 3, 1936, (weigh day) to June 24, 1937, (weigh day) was as follows:

Permanent pasture from July 3 to November 20, 1936, and from April 1, 1937, to June 24; a total of 234 days grazing.

Korean lespedeza from July 3, to August 24, and Abruzzi rye from October 23 to December 1, 1936, and from February 15, 1937, to May 10 except removed from February 28 to March 5 on account of snow. This gave 52 days grazing on lespedeza, and 118 days on rye, or a total of 170 days for the combination.

Korean lespedeza and Italian rye grass (both furnished some grazing) from July 3 to July 31, and from August 14 to 24. Then rye grass from October 23 to December 1, 1936, and February 15, 1937, to May 10 (except removed from February 28 to March 5 on account of snow).

This gave 38 days grazing on lespedeza and rye grass, and 118 days on rye grass, or a total of 156 days for the combination.

For the periods given above the following grazing hours and gains were produced:

Permanent Pasture: Sheep grazing hours, 22,360, and weaned-lamb grazing hours, 2,564. Total gain produced, 593 pounds.

Lespedeza and Rye: Sheep grazing hours, 17,984, and weaned-lamb grazing hours, 1,992. Total gain produced, 1,044 pounds.

Lespedeza and Rye Grass: Sheep grazing hours, 17,091. Total gain produced, 1,012 pounds.

In addition each of the three fields were grazed by 9 to 18 nursing lambs, (born in January, February and March) while their mothers were on these fields.

Some roughage was fed in all fields during bad weather, and a grain mixture was fed to the lambs and nursing ewes.

Considerable grazing was still available in the lespedeza fields when they were plowed for fall seeding of rye and rye grass. It was again very difficult to get a good stand of lespedeza in the rye grass, due to the sod.

The sheep and lambs in all three fields received ample grazing while in these fields, and again there was no significant difference in the gains

while all fields were being grazed. Each group remained in very satisfactory condition. However, during the winter season when the permanent pasture was not being grazed the groups on rye and rye grass made considerably larger gains than the permanent pasture group, which was on dry feed, and required much less hay. (J. E. Foster, R. E. Stitt, H. M. Vinall and E. H. Hostetler, Coop. Piedmont Station, Statesville, N. C., and BPI.)

Comparative Study of Quality of Meats of Yearling vs. Two-Year-Old Grade Hereford Steers.—This test was a repetition of last year's test and it included 13 yearlings and 9 two-year olds, all of which were out of Native Eastern Carolina cows and sired by a purebred Hereford bull.

Two pounds of cottonseed meal and 5 pounds of soybean hay per steer daily, and a full feed of shelled corn and corn stover were fed, from November 19 to April 8, a period of 140 days.

The yearlings, which were started at an average weight of 645 pounds, made an average daily gain of 2.17 pounds. The two-year-olds, which were started at 830 pounds, made an average daily gain of 2.06 pounds.

To produce 100 pounds gain the yearlings consumed 687 pounds of concentrates and 556 pounds of roughage, or 176 pounds less concentrates and 53 pounds less roughage than the two-year-olds. This resulted in \$2.84 per cwt. cheaper gains for the yearlings.

For the two trials combined the yearlings made more economical gains in the feed lots and were more profitable than the two year olds. The older cattle "dressed" higher, although their averaged carcass grade was the same as that of the yearlings. The raw lean meat of the yearling cattle was lighter in color and the rib cuts had a higher average percentage of "eye" muscle, and lower percentages of separable fat and edible portion. Also the corresponding rib cuts from the other side of the carcasses when roasted had slightly more aroma and flavor of lean, were more tender, less juicy, and the juice was less rich than those of the two-year-old cattle. (Earl H. Hostetler and J. E. Foster, Coop. Blackland Station, Wenona, N. C., and BAI.)

Value of Native Reeds for Summer Grazing.—At the Blackland Station, Wenona, native reeds (*Arundinaria tecta*) were the chief source of pasture for the beef herd.

On May 15, 1936, thirty native and grade Hereford cows, twenty-three grade calves, ten grade yearlings, nineteen grade two-year-olds, and one Hereford bull were turned on the reed pasture. On June 12 thirteen more similar yearlings were turned on the reeds, and on August 7 the bull was removed.

Since various irregular scattered areas of the reeds were killed by fire in early May no attempt was made to determine the carrying capacity per acre. The average daily gains though from May 15 to November 18 were as follows: Cows (23 of which were nursing calves) .52 pound; calves, 1.12 pounds; yearlings, .67 pound; and two-year-olds, .86 pound. The bull only lost 25 pounds during the breeding season from May 15 to August 7.

In addition, reed areas ungrazed during the summer maintained the weights of cows, two-year-olds, and yearlings from November 18 to January 14, a period of 57 days.

The herd was turned back on the first reed areas on May 11, 1937. From then until June 30 the cows made an average daily gain of 1.65 pounds, and their nursing calves 1.62 pounds. The yearling steers and heifers made an average daily gain of 1.73 pounds, and the two-year-old heifers 1.72 pounds. (J. E. Foster and Earl H. Hostetler, Coop. Blackland Station, Wenona, N. C., and BAI.)

Comparative Gains on Reed Pasture vs. Tame Pasture.—The tests of former years were repeated this year. However, due to scattered areas of the reeds being killed by fire the previous year, and the irregular stand of the tame pasture, no attempt was made to determine the grazing capacity per acre of the pastures.

Six yearling steers and heifers were grazed on the 10 acres of tame pasture from April 22, 1936, to November 18, a period of 210 days. During this time they made an average daily gain of 1.06 pounds.

Twenty-three similar yearlings were grazed on reeds. Ten were turned in the pasture on May 15, 1936, but the other thirteen were not put on reeds until June 12 since their area was burned over by a forest fire in early May. The average daily gain for the 187 day and 159 day periods combined was .67 pound.

In 1937 a repetition of the above test was started. On April 29 six yearlings were turned on the tame pasture. From then until June 30, a 62 day period, they made an average daily gain of 2.19 pounds.

Seventeen similar yearlings were turned on the reed pasture on May 11, and for the 50 day period to June 30, they made an average daily gain of 1.73 pounds. (J. E. Foster and Earl H. Hostetler, Coop. Blackland Station, Wenona, N. C., and BAI.)

Value of Crop Gleanings for Wintering Beef Cattle.—On January 14, 1937, the seventh year of gleaning studies was started by turning 19 cows and 11 three-year-old heifers into the corn stalk and soybean fields. The cattle were also given access to rye grazing at this time. Sixteen two-year-old heifers were turned into the stalk fields on February 27.

No harvested feed was given these cattle, except two feeds when snow was on the ground, from the time they were turned in the fields until March 30. During this time the dry cattle made slight gains. The cows with calves, except for loss in weight at calving, practically maintained their weights and produced rapid gains in their nursing calves.

Rye pasture furnished the entire feed for the above group from April 7 to 13.

In addition, the stalk fields and rye pasture furnished the entire roughage (except for a few days when snow was on the ground) for 23 weaned calves from November 30, 1936, to March 11. During this time the addition of only 50 pounds of cottonseed meal per day produced an average daily gain per calf of approximately .6 pound.

Some roughage and grazing was also available throughout the winter which greatly reduced the amounts of harvested feeds required. (J. E. Foster and Earl H. Hostetler, Coop. Blackland Station, Wenona, N. C.)

Vitamin "A" Studies with Cottonseed Meal Fed to Beef Cattle.—The fifth trial of this experiment, the plan of which was given in last year's report, was continued this year.

The 8 yearlings averaged 648 pounds on June 30, 1936, and, with the exception of one which calved on July 15, gained normally until slaughtered in January and February, 1937. The eight averaged 878 pounds on December 29 and were apparently normal in every way. The ante mortem, post mortem, and biological tests also showed that they were normal and were not showing deficiencies of vitamin "A". The one that calved reacted in a normal way and was continued on the same ration until slaughtered on April 14. It was then normal and in good condition.

The calf was kept in the dry lot with its mother and received her feed mixture. It weighed 53 pounds at birth, 220 pounds when weaned on December 15, and 470 pounds on June 29, at which time it was healthy and in good condition.

In these tests a ration composed of 26% cottonseed meal was not injurious if the ration contained a vitamin A source of 20% alfalfa hay, or 20 or 30% soybean hay. The calf and its mother received 30% soybean hay. Yellow corn composing 26% of the ration did not give ample protection. However, when 10% of the beet pulp in the ration was replaced with soybean hay the animals recovered and thrived. (J. O. Halverson, Earl H. Hostetler and J. E. Foster.)

Vitamins A, B, (B₁) and Flavin Component in Soybeans and Cowpeas.—The Vitamin B (B₁) work completed shows that one sample from each of the four varieties of soybeans, Tokyo, Biloxi, Mammoth Yellow, and Tarheel Black, contained an average of 28.6% as much vitamin B as a pure dehydrated yeast, both being estimated in international vitamin B units per gram. One sample from each of three varieties of cowpeas, Whip-poorwill, Brabham and Iron, contained an average of 21.1% as much as the dehydrated yeast, or 73.7% as much as the average found from the four varieties of soybeans.

The above results show that these samples of soybeans and cowpeas are rich in vitamin B.

The vitamin A and Flavin Content have not been completed. (F. W. Sherwood and J. O. Halverson.)

Finishing Beef Steers in Piedmont North Carolina.—Two lots of 15 yearling grade beef steers each, averaging 773 pounds, were fed from October 20, 1936, to February 13, 1937, a period of 116 days.

Both lots received a full feed of shelled corn and 2 pounds of cottonseed meal per head daily. Lot 1 was also full fed lespedeza hay, while Lot 2 received instead a full feed of cottonseed hulls and 5 pounds of lespedeza hay per head daily.

There was no appreciable difference in gains for the period. The steers in Lot 1 made an average daily gain of 2.30 pounds, and those in Lot 2, 2.25 pounds.

To produce 100 pounds gain the steers in Lot 1 consumed 654 pounds of concentrates, and 574 pounds of roughage, as compared with 658 pounds of concentrates and 603 pounds of roughage for Lot 2.

The steers in Lot 2, however, made \$1.50 per cwt. cheaper gains than those in Lot 1, and their necessary selling price per cwt. in order to break even was \$.41 less. This resulted in the combination of lespedeza hay and cottonseed hulls, fed in Lot 2, being a more profitable roughage

to feed than lespedeza hay alone as was fed in Lot 1. (Earl H. Hostetler, J. E. Foster and R. E. Nance.)

Roughage Studies with Beef Cattle.—The plan of this experiment and the first progressive report of the work was given last year.

The 24 Hereford calves which were born in the spring of 1936 averaged 229 pounds on June 16, and 453 pounds when weaned on December 1.

They were grazed the summer and fall of 1936 and carried through the winter at a medium plane of nutrition on roughage, winter pasture and 2 pounds of concentrates per head daily. The feed was discontinued on April 12, and on April 20 they averaged 529 pounds. At the last weigh day, June 15, they averaged 648 pounds.

Two groups of 10 animals each will be selected from the above yearlings in November and handled as outlined in last year's report.

The mothers of these animals were bred and cared for in the same way in 1936 and in the winter and spring of 1937 as during the previous year. On June 8, 1937, their 18 calves averaged 222 pounds. These calves will go on the same roughage comparison in November, 1938. (Earl H. Hostetler and J. E. Foster, Coop. BAI.)

A Study of the Changes in Meat and Wool Characteristics Resulting from the Use of Purebred Mutton Rams on Native Ewes.—The results of these studies were summarized in the report given last year. The experiment was completed during the summer of 1936, and a Station bulletin is now being prepared on this work. (J. E. Foster and Earl H. Hostetler.)

POULTRY INVESTIGATIONS

Investigations of Septicemic Diseases Among Fowls in North Carolina. Studies on Normal Agglutinins.—The work of this nature has not been adequately reported on or presented as a unit; therefore, some recapitulation is necessary.

The normal agglutinins in these studies have been determined by the use of antigens prepared from freshly isolated strains of pathogens of proven high sensitivity to the agglutination tests. The control agglutination tests are those carried out with the *Sal. pullorum* strains recommended by the Pullorum Disease Workers Conference as being the best diagnostic strains available. The latter has been used as the control in studies for normal agglutinins against both *Sal. pullorum* and *Sal. gallinarum* as the literature states these two pathogens have identical agglutinogens.

During 1934-35 a flock of 57 Rhode Island Red pullets were tested at monthly intervals for the presence of normal agglutinins for *Sal. gallinarum*. Over a period of 16 months this flock of birds showed a fairly steady increase in the incidence of normal agglutinins of from approximately 20 percent to 55 per cent. During 1936 this flock was broken up and only birds giving strong or interesting agglutination reactions were held.

During 1935-36 a flock of 50 Rhode Island Red and Barred Rock pullets were tested at monthly intervals for the presence of normal agglutinins for *Sal. pullorum*. The members of this flock were confined to hen batteries. Unlike the above in which there was an increase in the incidence

of normal agglutinins, practically all birds evidenced normal agglutinins from the start and have continued to do so.

In the fall of 1936 a third flock of Rhode Island Reds was started on tests for normal agglutinins to *Sal. pullorum* and their incidence was found to be quite uniformly present. It was felt that the results secured from the second flock might have been abnormal.

Tests have indicated that these so-called normal agglutinins are heat stable. Among the interesting tests observed are: Those in which the serum may be positive to the control antigen, yet negative to the more sensitive antigen; those in which the serum may be negative to one sensitive antigen yet positive to the other; and those giving atypical types of agglutination. From a given kind these interesting tests are fairly constant from month to month.

In future tests it is planned to include in these tests other members of the colon-typhoid intermediate group and to attempt to isolate members of this group from the organs of certain birds. (R. S. Dearstyne, R. E. Greaves and H. C. Gauger.)

Investigation of Septicemic Diseases Among Fowls in North Carolina. A Search for a "Virulence" antigen in *Sal. pullorum*, *Sal. gallinarum*, and *Sal. aertrycke*.—In these studies antisera were to be produced against each pathogen in rabbits and birds.

Because of unpredictable difficulties, entirely satisfactory antisera having a sufficiently high agglutination titer were not produced. Birds cannot be immunized with the live, highly virulent *Sal. gallinarum* strains included in these studies nor can rabbits be immunized with the live, highly virulent *Sal. aertrycke* strain. Death invariably follows even after immunization with killed cultures. When injected with *Sal. aertrycke*, birds have produced exceptionally high titers, even exceeding 1 to 100,000, but it has not been possible to produce in them titers of 1 to 10,000 by the injections of *Sal. pullorum* or *Sal. gallinarum* (live or killed cultures) even after hyper-immunization.

Preliminary absorption and agglutination tests carried out according to the technic of Felix and Pitt have been completed save for *Sal. gallinarum*. Apparently, in regard to *Sal. aertrycke*, the results of Felix and Pitt have been duplicated for the absorbed antisera (with acid treated antigen) has given a small flaking agglutination reaction similar to that for *Eb. typhi* when tested against the live organism. The *Sal. gallinarum* antisera included in these tests was produced by the injection of a preserved bacterin—after absorption it gave no agglutination reaction with live antigen. The *Sal. pullorum* antisera included in these tests were produced by the injection of live culture—after absorption these gave an agglutination reaction with live antigen of the small flaking type. Tests have strongly indicated a cross-agglutination of the "V" type between *Sal. aertrycke* and *Sal. pullorum*—a result which was not expected.

Though confidence is felt in the results of these preliminary tests, the work is not yet sufficiently advanced to permit commitments. (R. S. Dearstyne, R. E. Greaves and H. C. Gauger.)

Paratyphoid Infection in Pigeons.—Studies on pigeon paratyphoid were based on an outbreak of this disease in the lofts of a commercial pigeon

breeder of this state. Birds sent in for diagnosis revealed the presence of *Sal. aertrycke*.

Shortly after recovery of the above organisms a stained antigen for a rapid whole blood test was prepared from the organism recovered from the liver of squab 16417. With this antigen a rapid whole blood test was made on all birds at the Loft except the nestlings. The technic of testing was identical with that used in the detection of chronic carriers of pul-lorum disease. Out of approximately 500 birds tested, 55 were removed as reactors and brought to the College laboratories, where each bird was individually penned for further study.

Two months after the first blood test all birds in the loft except nestlings were tested a second time. The second test included birds which were nestlings at the first test. Out of approximately 425 birds tested, 24 were removed as reactors and brought to the College laboratory and individually penned. The majority of reactor birds removed on the second testing period were nestlings at the time the first test was applied. At the time of the testing the blood of only a very few of the reactors produced a distinct, rapid, large size clumping of the stained antigen. In most cases the reaction was slow (all reactions read within two minutes) and the clumps, although very numerous, were fine to medium in size.

Soon after being placed in the College laboratories a standard titre agglutination test was carried out on the blood from each bird. Antigens for the tube test were prepared from the same strain used in the preparation of the stained antigen and from known strains of *S. aertrycke* (mouse recovery) *S. Schottmulleri* (B) and *S. paratyphoid* (A).

The serum from all but seven birds produced complete or 4+ agglutination of the antigen prepared from squab culture in dilutions of 1:25 or higher. The serum of these seven birds produced 2+ and 3+ readings in the 1:25 dilution. The serum from eight birds tested produced no agglutination in a dilution of 1:25.

The titres obtained with the *S. aertrycke* and *S. Schottmuller* (B) were equal to or slightly less than the titres obtained with the squab culture antigen. The titres obtained with the *S. paratyphi* (A) were generally lower than recorded for all antigens mentioned above.

Following the tube agglutination tests a bacteriological study was made of the feces and the paryngeal and posterior nares fluids of ten birds which were removed from the loft by the first whole blood test (group I birds). Daily bacteriological tests were carried out over a period of three weeks. Paratyphoid organisms were recovered from the feces and from the pharyngeal and posterior nares fluids.

Shortly after the completion of the first tube agglutination tests the 24 reactor birds removed from the loft by the second whole blood test and one young bird sent in by the owner soon after the second whole blood test, were autopsied. At autopsy a bacteriological examination was made of the mouth fluids, the liver, spleen, pancreas, ovaries or tests, and lungs. In a few instances paratyphoid recoveries were obtained from the mouth fluids. Paratyphoid organisms were recovered from one or more of the internal organs in 21 of the 25 birds autopsied. The lungs and livers appeared to be the most common sites of focalization.

At present agglutination studies (stained antigens, H and O antigens)

are being carried out with serum from birds removed from the loft on the first whole blood-test (Group II).

Periodical agglutination tests will be carried out with the serum from Group II birds and a controlled breeding program will be carried out to determine whether the disease is transmitted through the egg or whether squabs become infected after hatching through bill feeding. (H. C. Gauger and R. S. Dearstyne.)

MISCELLANEOUS

Studies on the Use of Yeast in Poultry Feeding.—The project under study stressed the use of yeast fermented mash as a portion of the diet.

The studies at the Central Plant in Raleigh were as follows: Three year's tests, genetically controlled, in which S. C. White Leghorn pullets received the same basal diet, mash and grain, equal supplements, being made in the control pen of wet mash per bird to a supplement of yeast fermented mash in the test pen. Three year's studies on total number of eggs produced give the following results on an eleven months basis:

Pen	No. Birds (Total weighted average)	Eggs Per Bird	Feed Consumed Per Bird	
			Mash	Grain
Control.....	132	195	41.9	39.9
Test.....	132	200	42.9	41.6

Egg weights from fermented mash project (as above). The eggs laid by birds completing tests in above project were weighed on Toledo egg scale graduated to 32d of an ounce. The following comparative weights were obtained :

Year	Control		Test	
	No. Eggs	Average weight oz. — 32d	No. Eggs	Average weight oz. + 32d
1934-35.....	5584	1 275/320	5455	1 2787/3200
1935-36.....	7968	1 274/320	8091	1 279/320
1936-37.....	4735	1 29/32	4789	1 278/320

(R. S. Dearstyne, Coop. Northwestern Yeast Company, Chicago, Ill.)

A Study on the Relationship to Egg Production of Feeding a Portion of the Mash Fermented by Yeast.—These studies were conducted at the State Test Farm, Willard, N. C., for the past three years. During that time an aggregate of 321 S. C. Rhode Island Red pullets under test in both the control and the test pens. The basal diet of both pens was N. C. State laying mash and grain diet, sufficient to maintain body weight. The test pen received a supplement of yeast fermented mash in such quantity as the birds would clean up in thirty minutes.

The results on these trials showed 140 eggs per bird for the control pens and 150 eggs per bird for the test pen. The grain consumption per bird in the control pen was 48.6 pounds, and 48.7 pounds in the test pen. The mash consumption in the control pen was 41.7 pounds per bird, and 46.6 pounds per bird in the test pen. (R. S. Dearstyne, Chas. Dearing, and C. O. Bollinger.)

Tests on Feeding Wet Mash Supplements of Killed Yeast, Live Yeast and Yeast Fermented Mash.—These studies were conducted at the Central Plant for the past three years. The basal diets of these studies were as follows:

	Control	Supplement
Pen 1...	N. C. State Laying Mash: Grain	N. C. State Mash (wet)
Pen 2...	" + 1% killed yeast: Grain	Mash 2 fed wet
Pen 3...	" + 1% live yeast: Grain	Mash 3 fed wet
Pen 4...	" + 1% live yeast: Grain	Yeast fermented mash

The results of these tests over three years are as follows:

	No. Birds Total	Eggs Per Bird	Feed Consumed Per Bird	
			Mash	Grain
Pen 1.....	130	169	48.7	39.1
Pen 2.....	128	169	49.1	37.3
Pen 3.....	127	176	50.4	40.2
Pen 4.....	131	179	49.2	40.6

The supplementary feeding of wet mashes in pens 1, 2 and 3 were the basal mash wet and fed at once. Supplementary feedings were in such quantity as birds would clean up in thirty minutes. (R. S. Dearstyne.)

Studies of the Effect of Lighting Leghorn Pullets on Egg Production.—These studies were conducted during five months of 1936-37 at the State Test Farm at Swannanoa, N. C. Lighting was started October 1, a twelve-hour day being given, and morning lights being used. During the period of test no appreciable difference in egg production was noted. During 1937-38 a fourteen-hour day will be given the test birds. (R. S. Dearstyne, S. C. Clapp and G. K. Jones.)

Identification of Tapeworms Infesting Fowl in North Carolina and the Relationship of Tapeworm Infestation to Leg Weakness and Blindness of Fowl.—Fifty-eight of 89 chickens sent to the Poultry Disease Laboratory were found to harbor one or more species of tapeworms. Most of the chickens harbored only one species, but there were several cases of multiple infestation. North Carolina chickens appear to harbor five different species of tapeworms. The species transmitted by flies, namely,

Raillietina tetragona, *Raillietina cesticillus* and *Hymenolepis carioca*, are most prevalent. (Further investigation may disclose more species.)

The following is a list of the species of tapeworms found in chickens and the number of hosts infested:

<i>Raillietina tetragona</i>	38
<i>Hymenolepis carioca</i>	16
<i>Raillietina echinobothrida</i>	4
<i>Raillietina cesticillus</i>	2
<i>Choanotaenia infundibulum</i>	1

The following are the cases of multiple infestation found:

<i>Raillietina tetragona</i> and <i>Hymenolepis carioca</i>	5
<i>Raillietina echinobothrida</i> and <i>H. carioca</i>	2
<i>R. tetragona</i> and <i>R. echinobothrida</i>	1
<i>R. cesticillus</i> and <i>R. tetragona</i>	1

An insufficient number of hosts have been examined to date to draw any conclusions concerning distribution in the state. (R. Harkema and H. C. Gauger.)

A Study of the Influence of Line Breeding and Controlled Mating on the Livability of Poultry.—Six pen matings of S. C. White Leghorns were used for the hatching season of 1936-37. The females were chosen from three of the proven blood lines developed at the Central Plant, and consisted of 39 pullets, 36 birds in their first hen year, eight in the second, and three in the third. The females in pen 1 were entirely of line No. 64, and in each of the remaining five pens, lines 64, 32, and 77 were equally represented. Pens 1, 2, and 3 were assigned each a male from lines 64, 32, and 77, respectively, and the matings involved both inbreeding and outbreeding. A greater degree of outbreeding was accomplished in pens 4, 5, and 6 where the males used were obtained from three outstanding private breeders.

Six hatches totaling 1,736 chicks were made during the late winter and early spring. Individual weights were taken at hatching and at thirty day intervals for all birds up to and at three months of age. At that time the surviving birds consisted of 780 females and 785 males. All pullets were leg-banded, vaccinated for pox, and kept. They have been and are being weighed every thirty days until the time of sexual maturity. At four months of age the pullets were dewormed. At the present time approximately 60 per cent of the pullets have reached sexual maturity. Summary and analysis of growth curves will be made when all have become sexually mature. Possible relationship between growth curves and livability will be made at the end of the laying year of the pullets.

At three months of age the males were examined for disqualifications, and classified as culls or satisfactory for breeders. Reasons for culling were recorded. A small number of the superior males was retained from which breeders for the 1937-38 season will be chosen.

Since hatching, all cases of mortality have been recorded, with the cause of death determined in all cases where possible.

For the 1937-38 season a partial replacement of breeders is planned on the basis of data collected to date. The selection of breeders which will best satisfy the aims of the project is made more difficult by the fact that chicks must be hatched for the second year before pullets of the first have

completed one year of laying, and thus have demonstrated familial differences in livability. Differences in livability for the first six months are being considered in the selection of breeding stock. (C. H. Bostian, R. S. Dearstyne and J. J. Hutchinson.)

A Comparison of Combined Starter and Developer Mash to the N. C. Separate Starter and Developing Mash for Efficient and Economic Development of Chicks to Laying Age.—Two pens of 100 chicks each were started in this test. The chicks were hatched at the same time and genetically controlled. The control group was fed the N. C. starting mash (20 per cent protein) for the first twelve weeks, and developing mash (15.5 per cent protein) from then on. The test group was fed combined starter and grower (17.5 per cent protein) mash for the duration of the test. Grain was fed the control group from the sixth day on, being in approximately equal parts of mash and grain at the sixth week. The test group was fed grain at the sixth week and these birds were on approximately equal parts of mash and grain at the 12th week. Cockerels were removed at the 12th week and pullets continued until in ten percent production.

The results are tabulated below:

	Starter and Developer	Combined Starter and Grower	Starter and Developer	Starter and Grower Combined
Number birds in pen.....	96	96	56	49
Died.....	3	5	0	0
Pounds grain per bird.....	3.4	3.0	11.0	11.8
Pounds mash per bird.....	6.2	7.1	9.6	8.5
Total cost of feed per bird.....	0.229	0.239	0.467	0.451
Weight per bird—pounds.....	2.60	2.58	5.26	5.19
Grain per bird.....	2.51	2.48	2.66	2.63
Feed cost per pound gain.....	0.091	0.096	0.175	0.172

Results of these tests indicate little difference in results from these two systems of feeding. These are being continued during 1937. This test was duplicated in 1937 with Barred Plymouth Rocks at the College Test Farm, Raleigh, N. C., and with Rhode Island Reds at the State Test Farm, Willard, N. C. While the test is not completed, to date indications are that results will not be materially different from those in 1936. (R. S. Dearstyne.)

Cost of Production Studies.—Studies on performance and cost of egg production were carried out at State Test Farms at Swannanoa and at Willard, N. C., and at the State College Farm at Raleigh, N. C. The

period of test was from July 1, 1936, to June 30, 1937, and included both hens and pullets on the place. The results were as follows:

Station	Breed	No. Birds Weight Average	Eggs Per Bird	Feed Cost Per Dozen Eggs
Swannanoa.....	R. I. Reds	106	155	18.1
Swannanoa.....	S. C. W. Legs	353	166	15.5
Willard.....	R. I. Reds	297	145	19.2
Raleigh.....	R. I. Reds	174	160	16.6
Raleigh.....	B. P. Rocks	177	168	16.7
Raleigh.....	S. C. W. Legs	665	201	13.5
(R. S. Dearstyne)				

III. HUMAN PROBLEMS IN AGRICULTURE

A Study of Social Activities and Problems of North Carolina Farm Youths.—The object of this study is to indicate the relationships between certain economic and social factors and the status, activities, interests and needs of farm youths. A derivative objective is to ascertain facts pertinent to the development of programs to serve the need of rural young people. To attain this objective a survey was made during the past year of 252 farm households in Guilford county, Jefferson township, and of 229 households in Union county, Marshville township. All tabulations have been completed, and the results have been embodied in manuscript. Detailed maps have been prepared showing the location of all households surveyed. The results of the study are representative of areas of cash-crop farming in Piedmont North Carolina in the vicinity of manufacturing centers. In addition to data from this survey information from the studies of recent changes in the social and economic status of farm families has been utilized in an analysis of the selectivity of rural-urban migration among youths of rural households.

Analyses touch upon the following topics: Occupations, occupational choices and anticipations, economic status, migration, educational status and plans for training, social participation, family backgrounds. The data indicate the presence of problems in the fields of education and social activities which have, as yet, received little attention in the communities studied, notably misadaptations in type of training received and apathy toward organizations designed to improve community life for young people. Certain institutions were found to add obstacles to the development of vigorous organizations for young folk. (R. M. Williams.)

A Study of Changes in Taxes Levied upon Farm Real Estate in North Carolina from 1913 to 1935.—The original purpose of this study was to record simply the changes in the rate of taxation on farm real estate in North Carolina. But in 1932, after the tax rates had been obtained from 1913 to 1931 on 213 farms located in twenty-three counties, it was deemed advisable to broaden the objective so as to include a study of the major causes of and the more important social and economic implications involved in changes in tax rates. To attain this objective the statistical

base of the study was expanded by increasing the number of farms from 213 in 1913 to 423 in 1920, and to 820 in 1935. The number of counties was also increased from the original number of twenty-three in 1913 to thirty-one in 1920, and to fifty-two in 1935. The tax data, such as the assessed valuation of real estate and personal property, the amount of taxes paid, and the tax rate, were obtained directly from the county tax records.

The period included in this study is characterized by marked changes in the economic position of farmers. For the war and post-war period from 1913 to 1920 the economic condition of agriculture in the state may be considered as satisfactory. There was a decided improvement in prices of farm products from 1913 to 1919. The collapse in prices in 1920 was followed by a rise to 1928 when once more the price structure collapsed. The decline in prices from 1928 to 1932 was precipitous. For example, cotton prices which averaged 16.7 cents per pound during 1929 declined to an average of 6.1 cents for 1932. Similarly, tobacco prices declined from 18.5 cents in 1929 to 8.8 cents in 1931. The gross cash income of all farm products in the state declined from about 411 million dollars to slightly more than 186 million dollars between 1929 and 1932. The net cash income declined even more than the gross cash income. In 1929 the net cash income of all farms was approximately 235 million dollars, but only 54 million dollars in 1932.

The period is also characterized by rapid and marked changes in the tax rate on farm real estate. From 1913 to 1918, a period of advancing farm incomes, the tax rates per acre moved from an average of 10 cents per acre to 15 cents in 1918, and to 64 cents in 1928. Thus, in a span of fifteen years, the tax rate advanced 540 per cent. The tax rates reached the peak in 1928, and then declined rapidly in sympathy with declining farm incomes. In 1934 the tax rate was 33 cents per acre, or 48.4 per cent less than it was in 1928, but still 230 per cent higher than in 1913. These and other data relating to the farm tax problem in North Carolina, together with suggested remedies for changes in tax rates, are presented in a manuscript which has been prepared for publication. (G. W. Forster.)

The Effects of a Definitely Planned Soil Conservation Program upon Social Participation of Farm Families in Franklin County.—The sociological phases of this project fall into three main subjects:

1. Historical Study of Land Tenure. By the end of the fiscal year 1937-38 a report will have been completed showing (a) complete ownership history of each land tract in the demonstration area, (b) farm maps of the area at 10-year intervals from the land grants until the present, (c) cycles, if any, in land concentration or land distribution, (d) analysis of any factors found to be responsible for land accumulation or for breaking of large estates or for loss of farms among various classes, e.g., soil types, owner types, and type-of-farming.

2. Occupational Status and History. Field work was begun on the filling of family schedules for every farm family in the area mentioned above. These schedules show (a) occupational history by years for each family head, (b) migration (by place and date) for every person now living in the area, and also for the siblings of all household heads and their spouses, (c) occupational changes coincident with migration, (d) birth rates for mothers now resident in the area, as well as birth rates

for the mothers of all family heads and their spouses. Since some households now residing in the area have married daughters also residing in the area, it will be possible to build up a picture of birth rate changes over a three-generation period. An interesting part of the study will be concerned with changes during the next ten years in trends for mobility, migration, birth rates, and other factors studied in the family schedule, (e) permeability of farm tenure strata to marriage—data obtained for three generations, (f) school grade completed for each person or resident in the area supplemented as the study progresses by educational progress of each child throughout whatever period the study may continue, (g) age at marriage for three generations up to 1937, similar data being continued throughout the period for which the study is maintained, (h) family participation in the various community activities (these data also to be continued on an annual basis for the duration of the study).

Since approximately one-half of the families are cooperating with the (Soil Conservation Service) S.C.S., it will be possible over a ten-year period to ascertain rather effectively the influence of the S.C.S. on most of the factors enumerated above. A report to be prepared by the end of June 1938, will analyze the initial situation and set the stage for a study of changes which may occur during the first decade subsequent to the inauguration of the S.C.S. in this demonstration area.

3. Condition of Farm Dwellings. Coincident with the taking of family schedules a detailed schedule is being filled for each dwelling house included in the survey. This schedule provides numerical ratings for three-score of structural and equipment items. Photographs accompany these schedules. Similar schedules filled annually throughout the duration of this study will indicate improvements and deterioration by items. The numerical ratings will make it possible to show graphically the general trends in deterioration and improvement of dwellings. (Cooperation Soil Conservation Service, Bureau of Agricultural Economics, M. Taylor Matthews.)

Cotton Marketing in the Salisbury Area of North Carolina.—The results of this study are being published in the form of a bulletin. It is an economic study of the quality of cotton produced and consumed locally, of marketing practices and attitudes of farmers and local buyers, and of buying practices and preferences of local mills. The cooperating agencies were the North Carolina Agricultural Experiment Station, the Bureau of Agricultural Economics, and the Bureau of Plant Industry. Data were obtained for the years 1935-36 and 1936-37. The summary and major conclusions are:

1. Cotton consumption greatly exceeds production within the area.
2. There is usually a single marketing agency between grower and spinner.
3. More than one-half of the cotton bought by gin operators was purchased without examination for quality.
4. In general, growers in the area are not adequately informed with respect to market prices, and particularly with respect to differentials for differences in quality.
5. An analysis of prices received by growers preceding and during the period in which classification and market news services were available do not indicate that these services were particularly effective in

influencing local marketing practices from the standpoint of recognition of quality of individual lots of cotton involved in grower-first-buyer transactions.

6. Apathy on the part of the major portion of the cotton growers in the area toward making use of services designed to improve their bargaining position may be attributed to two conditions: (a) Since cotton is a minor farm enterprise there appears, from an economic standpoint, to be very little jurisdiction for incurring extra inconveniences and expenses in an attempt to secure exact market value based on the merits of each individual bale. (b) As local buyers show preference for cotton ginned at their plants, farmers are discouraged in obtaining several bids before sale.

(Cooperation Bureau of Agricultural Economics and Bureau of Plant Industry, Glenn R. Smith, J. W. Wright and J. A. Shanklin.)

Cotton Marketing Practices in the Coastal Plain Area of North Carolina. This investigation is a study of the market area, the structure of the local market, the buying and selling practices of local buyers, the selling practices of farmers, and the movement of cotton. Four marketing areas representing the Coastal Plain region of North Carolina were selected for study. Farmers, local buyers, ginnermen, public weighers, and warehousemen were interviewed in each area, and data were recorded on questionnaires prepared for that purpose. Data obtained are being analyzed with a view to presenting a clear picture of the present system of marketing and to suggesting possible improvements or changes that would be beneficial to the farmer. (Cooperation Bureau of Agricultural Economics, Glenn R. Smith and J. W. Wright.)

MARKETING

The Organization, Practices, and Membership Participation in Two North Carolina Farm Cooperatives.—This study was completed in 1935-36, with the exception of final revision of the manuscript for publication, which was completed in July, 1936. It has been published in Agricultural Experiment Station Bulletin No. 311. (S. L. Clement.)

Marketing of Flue-cured Tobacco in North Carolina.—The immediate objective of this study is to determine the effect on quality of tobacco of the methods and practices used by tobacco producers. Some of the factors considered are: Cropping system, soil type, fertilizer practices, variety planted, grading practices, selling practices, and personal factors. Other ultimate objectives are the following:

- (a) To analyze daily and seasonal fluctuations in prices on selected markets.
- (b) To determine the value to the grower of government grading and market news service.
- (c) To study the efficiency of the auction warehouse system.

Granville county was selected for study in 1936-37. With the aid of the county agent of that county 200 growers were selected, each of whom agreed to keep detailed records of their tobacco sales, including the date of sale, price received, and federal grade of each lot sold. During the marketing season each of the 200 growers was interviewed for the purpose of obtaining information on production and marketing practices.

The data are being analyzed, but no publication of the results for 1936-

37 is contemplated. The study will be continued in 1937-38 on the Farmville, North Carolina, market area. (S. L. Clement.)

Survey of North Carolina Farm Cooperatives.—This survey was conducted in cooperation with the Columbia Bank for Cooperatives, of the Farm Credit Administration. The purpose was to obtain accurate current information concerning the organization, financial status, and business of every farm business cooperative in the state. The information was obtained by personal interviews with the officials of the associations and recorded on questionnaires prepared by the Farm Credit Administration. Complete records were secured for 203 associations operating in 1937, including 100 marketing and purchasing organizations, 69 soil conservation associations, and 34 home demonstration curb markets. In addition to the information concerning associations still in operation, certain facts were obtained concerning approximately 75 associations which had ceased operation within the past several years. No analysis of the records has been made as yet. (S. L. Clement.)

Rural Relief.—The first four months of 1936 were devoted mainly to completion of a 364-page manuscript entitled: "The Challenge of Rural Dependency in North Carolina." This study includes detailed monthly case analyses of a fifty-percent sample of households added to (also dropped from) relief rolls, similar case analyses for a cross-section sample of all relief cases in June 1935, and in October 1935, and a follow-up analysis of a fifty per cent sample of all cases closed July-October, 1935, showing the economic situation of these households as of December, 1935. Finally, the report includes a detailed study of monthly expenditures and of case loads for relief agencies (both public and private) in twelve sample counties, January 1931 through June 1936. (Cooperation Works Progress Administration, M. Taylor Matthews.)

Current Changes Survey was carried over from 1935 on a much restricted basis, involving monthly reports of case loads and total expenditures for each relief agency (public and private) in twelve sample counties. (Cooperation Works Progress Administration, M. Taylor Matthews.)

The North Carolina Agricultural Experiment Station,
In Account with Farm and Miscellaneous Receipts.

Dr.

	Balance from Previous Year	Receipts for 1937	Total
State Department of Agriculture.....	-----	\$ 26,350.00	\$ 26,350.00
Brushy Mountain Apple Research.....	-----	5,000.00	5,000.00
Special endowments, industrial fellowships and similar grants.....	-----	3,196.94	3,196.94
Sales.....	-----	17,328.27	17,328.27
Miscellaneous.....	\$ 2,887.12	1,781.90	4,669.02
Total.....	\$ 2,887.12	\$ 53,657.11	\$ 56,544.23

Cr.

Salaries.....	\$ 19,398.03
Labor.....	10,781.75
Stationery and office supplies.....	358.62
Scientific supplies, consumable.....	243.68
Feeding stuffs.....	3,646.29
Fertilizers.....	218.04
Sundry supplies.....	1,930.48
Communication service.....	585.12
Travel expense.....	3,472.20
Transportation of things.....	80.29
Heat, light, water, power.....	304.27
Contingent expenses.....	5,942.11
Furniture, furnishings and fixtures.....	269.80
Library.....	11.42
Scientific equipment.....	299.02
Tools, machinery and appliances.....	2,898.96
Livestock.....	1,779.90
Buildings.....	1,518.65
Land.....	75.75
Unexpended balance.....	2,729.85
Total.....	\$ 56,544.23

IV. FINANCIAL STATEMENT

The following is a certified statement of the receipts from the Treasurer of the United States, supplementary funds from the State Department of Agriculture, and sales from the Station farms, with a record of their disbursements:

	FEDERAL FUNDS				Bankhead-Jones Offset
	Hatch Fund	Adams Fund	Purnell Fund	Bankhead-Jones Fund	
Dr.					
To receipts from the Treasury of the United States, as per appropriations for fiscal year ended June 30, 1937.....	\$ 15,000.00	\$ 15,000.00	\$ 60,000.00	\$ 51,314.00	\$133,249.06
Cr.					
Personal services.....	\$ 12,253.85	\$ 12,326.52	\$ 44,678.09	\$ 43,147.97	\$ 76,589.72
Supplies and materials.....	676.81	890.42	7,379.72	1,801.60	17,110.57
Communication service.....	214.86	7.65	177.11	32.19	1,294.54
Travel expense.....	966.26	833.73	3,449.34	3,592.78	6,723.39
Transportation of things.....	65.21	19.46	117.56	158.54	652.44
Printing and illustrating publications.....	460.52	-----	2,233.32	39.60	139.40
Heat, light, water, and power.....	-----	15.32	33.96	243.57	3,649.40
Contingent expenses.....	36.00	-----	1.44	2.09	2,189.78
Equipment.....	316.52	883.15	1,913.81	2,091.87	6,651.31
Buildings and land.....	9.97	23.75	15.65	203.79	18,248.61
Total.....	\$ 15,000.00	\$ 15,000.00	\$ 60,000.00	\$ 51,314.00	\$133,249.16

Interest earned on above, during the period indicated, aggregating --NOTHING--, was covered by check No.--NONE--, drawn by--xxxx--, to the order of the Department of Agriculture to be deposited in the United States Treasury.

We, the undersigned, duly appointed auditors of the expenditures from Federal appropriations and Bankhead-Jones offset funds reported herein, do hereby certify that we have examined the books and accounts of the North Carolina Station for the fiscal year ended June 30, 1937, that we have found the same well kept and classified as required, and that the balances, receipts, and disbursements are as follows:

	FEDERAL FUNDS					Bankhead-Jones Officer
	Hatch	Adams	Purnell	Bankhead-Jones	Total Federal Funds	
Balance from preceding year.....	None	None	None	None	None	
Receipts from the Treasurer of the United States.....	\$ 15,000.00	\$ 15,000.00	\$ 60,000.00	\$ 51,314.00	\$ 141,314.00	
Receipts from sources within the State.....	-----	-----	-----	-----	-----	\$ 133,249.06
Total.....	\$ 15,000.00	\$ 15,000.00	\$ 60,000.00	\$ 51,314.00	\$ 141,314.00	\$ 133,249.06
Disbursements.....	15,000.00	15,000.00	60,000.00	51,314.00	141,314.00	133,249.06
Balance June 30, 1937.....	None	None	None	None	None	

Proper vouchers for the above disbursements are on file and have been examined by us and found correct.

We further certify that the expenditures have been solely for the purpose set forth in the Acts of Congress approved March 2, 1887, March 16, 1906, February 24, 1925, and June 29, 1935, and in accordance with the terms of said acts, respectively.

(Signed) R. Y. WINTERS,

Director of the Experiment Station

A. F. BOWEN, Treasurer

Financial Office of the Institution

H. M. LONDON,

Secretary of the Governing Board

Auditors

ATTEST:

A. F. BOWEN,

Custodian of the Seal.

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